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The Institute of Vitreous Enamellers

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and

The Foundry Trades' Equipment and Supplies Association

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Profitable Co-operation

Gradually, the foundry industry is improving and strengthening its employers' organisations. Some district associations are in a thoroughly satisfactory position in this respect, but in general they fail to provide themselves with the fundamental statistics of the district. It is usually postulated that this type of work costs money which can be ill-afforded, yet it is more than possible that it can be obtained free of charge. In one case which has come to our notice the industrial research department of an American University takes care of the collection and analysis of the essential statistics of the local foundry industry. Such a system gives life to the work of the University, and is of distinct interest to the industry served. Moreover, there is a feeling that confidential matters will be adequately safeguarded by such a system. The report which the University provides is given under the following horizontal headings, and to render its description more easy of visualisation, it will be presumed that the report is the one published in January, 1938. These columns are headed: "Number of firms reporting December and November, 1937"; "December, 1937, Tons"; "Per Cent. Change from November, 1937"; "Number of Firms Reporting December, 1937, and December, 1936," and "Per Cent. Change from 1936." The vertical columns give information under the following heads: "Production," covering sub-headings of "Jobbing" and "In Further Manufacture"; "Deliveries"; "Unfulfilled Orders"; "Raw Materials," with sub-headings to cover "Pig-Iron," "Scrap" and "Coke." Apparently this method of expression takes care of cases where the firms fail to send in any or incomplete returns. It also takes care of the exceptional, such as a foundry using pulverised fuel or oil instead of coke for melting; the initial incidence of such installations would obviously profoundly affect the statistics presented on any other basis. This, of course, is quite secondary to the basic idea that through the co-operation of the foundries with the University authorities the former would receive worth while statistics, whilst the latter should find the work of dealing with "live" statistics of superior teaching value, than by traversing hypothetical cases, or those of a nationally broadcast variety. The question is well worth an investigation by both parties.

Graphite

To the ironfounder few materials are more interesting and important than graphite, which finds many uses as a facing material and which is an inevitable constituent of all grey cast irons. It constitutes, indeed, the main difference between these cast irons and the steels. To the blast furnacemen at the pig bed and to founders of certain special types of castings it is familiar and ever present as kish. To the metallurgist it is present in the metal in an astonishing range of sizes and shapes, affecting the properties in a way which seems out of proportion to the precise amount of variation of graphite in different irons. It is generally considered to be chemically similar to other forms of carbon, and to have a specific gravity of 2.25, less than a third of that of iron itself. It is also believed that the various forms it takes in cast iron, such as flake graphite, temper carbon, and fine graphite, are identical with one another, yet much remains to be learned about it. The point at which and the manner in which it first makes its appearance in the cooling melt are still matters of controversy, and the process of diffusion is more a matter of inference than of evidence. Even the method of examination by the microscope leaves much to be desired, for by the usual method of polishing and preparing metallic surfaces the areas revealing the size and distribution of graphite are in general either the cavities themselves from which graphite has been torn in the process or cavities which have inevitably been filled with the polishing powder. It is well known that some methods of polishing will burnish over and partly fill in the cavities and appear to give a finer graphite distribution, while others will tear out material and make the distribution seem greater. There is, therefore, much to be said for the work being done on graphite in various directions, such as on its crystal structure and on X-ray examination. Some of this is incidental to the study of coke, and altogether we may look forward with confidence to the elucidation of the mysteries of graphite in the not too distant future.

Correspondence

[*We accept no responsibility for the statements made or the opinions expressed by our correspondents.*]

Contraction of Iron Castings

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Mr. E. Longden's excellent Paper, "Design in Relationship to Contraction and Distortion," should find a place in every engineer's and foundryman's text-book. But there is something wrong under the heading "Contraction Tests, Single Bar Castings," illustrated by Fig. 5D, which becomes the more puzzling after reading the earlier portion of the Paper.

Taking diagram D, to which Mr. Longden presumably refers, where he says he has encountered contraction phenomena, *i.e.*, "that thicker sections contract more than thinner sections," of course, with the same metal cast at the same temperature into the same mould and under normal conditions, excluding chilling or the like, this cannot be so. What has happened with the casting diagram D is that the mould has been "constricted" or squeezed in the process of each member cooling.

First, the very thin bar on the extreme right has cooled and contracted, and pulled the mould with it. After the very thin bar has cooled, the adjoining bar, which is a little thicker, has then to commence its process of final cooling, and so on, until the whole casting in stages has cooled, each bar in turn constricting its neighbour, which during the process is in a semi-molten state. The extraordinary shortening of the thicker bar ceases to be a contraction phenomena; it is just a physical action due to constriction.—Yours, etc., "MANCUNIAN."

Calcium Carbonate Inclusions in Moulding Sand

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I am interested in Mr. E. J. Crawley's letter published in your issue of February 10 under the above heading, and the following conclusions based upon my work on moulding sands may be of value.

In the first place, one rather welcomes a letter of this type as, in view of the amount of investigation now being conducted on foundry sands, little attempt has been as yet made to apply the science of mineralogy. This is to be regretted, as quite apart from academic interest the physical and chemical properties of the mineral substances in sand play a very important part in practical operations. Accordingly it is hoped that Mr. Crawley's remarks may awaken a more active interest in this direction. Twenty years ago Prof. Boswell, in his now well-known work "British Resources of Refractory Sands," emphasised the above remarks, and it is time something was done on the matter.

Free calcium carbonate in the form of limestone, chalk, or calcite ($CaCO_3$), when heated changes to lime (CaO). Its melting point is stated as 2,570 deg. C., which is much higher than quartz. From the point of view of refractoriness alone, therefore, one might assume that the presence of free calcium carbonate is an asset.

Cement is made by heating all alluvial shale or clay together with calcium carbonate, and the result is still, as has been proved by the Randupson method of moulding, a satisfactory bonding material suitable for steel, iron or non-ferrous castings.

The mineral Anorthite, a lime-felspar, contains 20.1 per cent. lime, 36.7 per cent. alumina, 43.2 per cent. silica, and has a melting point of 1,550 deg. C.

These examples indicate that the presence of free limestone or chalk is not likely to lower unduly the refractoriness of a pure sand consisting of silica and alumina. On the other hand, the dissociation of limestone into lime causes carbon dioxide gas to be evolved, and care must be therefore exercised in the venting of sands containing any appreciable quantities of limestone. In practice the writer has used sand containing 9 per cent. free calcium carbonate for making large grey iron castings up to 60 tons without undue trouble, although it must be admitted without enthusiasm. More foolproof results were ultimately obtained by using a sand free from limestone.

There are other minerals likely to be present in foundry sand which are more dangerous than the above. For example, iron oxide can exist in several forms, and when in a partially oxidised condition as ferrous oxide (FeO) it is particularly detrimental, reacting to form relatively fusible silicates. On the other hand, when in the anhydrous state as hematite (Fe_2O_3), it need cause little worry. Chemical analysis cannot, however, detect such combinations, and their true effect in founding will only become evident by a study of mineralogy. A Paper on this subject as applied to moulding sands, written by one familiar with foundry operations in a style likely to be assimilated by foundry executives, would prove a great future asset.—Yours, etc.,

F. HUDSON.

Thames House, Millbank, London, S.W.1.

Custom of the Trade

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—Your correspondent "Ecossais" questions, in the February 10 number of the JOURNAL, the correctness of the last paragraph of my letter published in your issue of January 20. The assertion there made is, however, correct.

I would suggest "Ecossais" has overlooked the words "other people's castings" in the second line of the paragraph. A machinist who machines castings he has bought operates on *his own castings*, which is a quite different circumstance.

"Ecossais's" implied suggestion that a machinist has no remedy against a founder who has supplied him with faulty castings is not necessarily correct, though I had not stated the contrary. Unless a contract says that a founder accepts no responsibility for any unsoundness of castings he has sold, there might be several types of faults in castings which rendered him responsible to the machinist for loss of money directly due to such faults. Broadly speaking, faults resulting from bad foundry technique or carelessness would be the responsibility of the founder. Faults inseparable from the nature of a metal correctly handled, or as near to the latter as reasonable skill knows, would be the burden of the purchaser of the castings, unless the founder had in some manner warranted the castings for their intended purpose.

That founders must have higher prices to meet the cost of wasted machining, if machinists insist on an indemnity when they can, is profoundly correct. The absence of such appropriate remuneration would not help the founder who was assailable, whatever he might think was the justice of the case from the price paid for the material.—Yours, etc., "FOUNDRYIST."

The Use of Scrap Grinding Wheels as Mould Chills

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the Paper presented to the Sheffield Branch of the Institute of British Foundrymen by Mr. W. H. Salmon, entitled "Scrap Grinding Wheels used as Foundry Refractories," and published in your issue of December 2, 1937, page 427, we should like to point out that the process described in connection with the use of scrap grinding wheels as a "chill"—the word being used in the foundry sense—is covered by Patent Specification No. 470,972, entitled "Improvements in and relating to the Casting of Metal Objects," granted to H. Smith and C. A. Parsons & Company, Limited.—Yours, etc.,

For C. A. Parsons & Company, Limited,
G. BEDFORD, Director.

Heaton Works,
Newcastle-upon-Tyne, 6.

Random Shots

Some obviously well-informed man the other day remarked that the Institute of British Foundrymen is a very live body. This is certainly true; indeed the title, "Institute of British Foundrymen," has become a household term in foundry circles; so much so that the full phrase has long since become too much of a mouthful. Nowadays, it is usually given the homely and familiar form of "I.B.F."

* * *

But, talking of these shortened forms of address, who would dare to be so flippant as to refer to the I.M. when he means the Institute of Metals? And to call the Iron and Steel Institute the "I.S.I." might almost be considered a breach of professional etiquette!

* * *

For all that, the foundrymen are lucky in their choice of initials, for they have a euphonious sound, and, moreover, they form a sort of "magic three," whose combinations are innumerable.

* * *

Besides the I.B.F. there is the B.I.F., and at this juncture it is scarcely necessary to translate that, opening next week as it does. Then there is the F.B.I., the Federation of British Industries, that august body which does such fine work in the High Places. Forget not, too, that little FIB which the lad tells his boss when he is caught redhanded with the betting slips.

* * *

Lastly, of course, every community, except perhaps the foundry fraternity, has its B.F., but the "I" in this case is always patently absent.

* * *

Incidentally one would hardly expect the B.C.I.R.A. to have a duplicate, being such an unusual combination of initials. Besides being the British Cast Iron Research Association so familiar to foundrymen, it also stands for the British Cotton Industry Research Association.

* * *

It is a pity that in the reports of speeches at dinners the stories are usually blue pencilled by the Editor and therefore never appear in print. It is a pity, because as a rule they are both good AND printable. The ease with which one remembers after-dinner stories varies inversely with the quality of the wine at dinner and in direct ratio to the number of cocktails taken beforehand. It is often with regret that one realises next morning that one has forgotten the real kernel of the previous night's stories.

* * *

Besides, they are so eminently suitable to tell the wife on those rare occasions when there is a pause in her chatter.

* * *

Two such stories were told at the recent Lancashire Branch dinner held in Manchester.

The junior clerk was left in charge of the office whilst his boss went to Blackpool for a brief "pick-me-up." On his return the boss asked junior what work he had done in his absence.

"I've been counting flies," said he. "Counting flies?" questioned the astonished boss. "And what did you learn from that, pray?"

"There were 5 flies, sir, 3 gentlemen and 2 ladies."

"And how did you find that out, please?"

"The gentlemen flies buzzed continuously round the beer bottles, and the ladies spent their time on the mirror."

* * *

The other one was a story of a parson, a one-time schoolmaster, who read out the ten commandments for the benefit of his Sunday morning audience. Being slightly absent-minded that morning he finished up with "these are the ten commandments of the Lord, but only five need be attempted." "MARKSMAN."

The Casting of Nickel-Silver for Foundry Purposes

By F. HUDSON*

Nickel-silver castings can be readily produced in the foundry providing one or two facts of a fundamental nature are fully understood. All non-ferrous alloys containing appreciable quantities of nickel are susceptible to gas absorption during melting, particularly so far as hydrogen is concerned, and accordingly precautions must be taken during founding to minimise this action by rapid melting in a slightly oxidising atmosphere. One cannot emphasise too strongly the importance of this statement; if it is ignored, then castings with varying degrees of porosity will result.

It will be appreciated that hydrogen capable of combining with the nickel-copper base metal cannot usually exist in the presence of free oxygen, but in a reducing atmosphere, which is common to many natural-draft coke-fired furnaces, its presence is a serious factor and will have an important effect on casting quality unless suitable modifications in melting technique are made. The initial effect of gases present during the melting period is probably the greatest factor arising in the production of commercial nickel-silver castings. Following the adoption of correct melting conditions the problems of composition, de-oxidation treatment, pouring temperature and moulding methods must all receive proper consideration if satisfactory castings are to be produced, and the following remarks have been drawn up for the guidance of the non-ferrous foundrymen in handling these alloys.

Composition

The variety of casting alloys used in the industry covers a wide field, as will be observed from Table I. The name "nickel-silver" is normally applied to metals essentially containing between 10 to 30 per cent. nickel and 5 to 45 per cent. zinc, the balance being copper. These alloys have been very widely used in the past for fabricated sections, namely: bars, tubes, sheets, strip and wire, etc., as required for the manufacture of cutlery, tableware, spun ornaments, springs and other articles. Within recent years a demand has also arisen for the production of the alloy in cast forms, for example, cocks and taps, bathroom and toilet fittings, valves, railway carriage, ship and automobile fittings, die-castings, refrigerator and other plant for the food industries, ornamental castings, etc., and it has been found that some modification in composition over that normally used for fabricated sections is desirable if satisfactory results are to be obtained. This statement particularly applies to the casting of pressure work such as valves, taps and cocks. The effect of the individual elements so far as casting production is concerned can be outlined as below.

TABLE I.—*Composition of Typical Nickel-Silver Casting Alloys at Present used in the Industry.*

Mark.	Composition, per cent.							Remarks.
	Nickel.	Copper.	Zinc.	Tin.	Lead.	Manganese.	Iron plus other impurities.	
A	14.0	74.0	8.0	4.0	—	—	—	Valve fittings.
B	15.0	57.0	17.5	2.5	7.0	trace.	1.0	Cocks and taps.
C	15.0	51.0	25.0	2.0	7.0	—	—	Castings for refrigerator plant.
D	15.0	45.0	38.0	2.0	—	—	—	Hard castings for special purposes.
E	16.0	42.0	41.0	—	1.0	—	—	Pressure die-castings.
F	17·0/19.0	60·5/63.5	18·0/22.0	—	—	—	0.3	Belgian Railways, carriage fittings.
G	18.0	62.0	20.0	—	—	—	0.3	French Railways, carriage fittings.
H	19.0 Min.	62.0 Min.	10.0 Max.	2.5/4.0	6.0 Max.	1.0 Max.	1.0 Max.	U.S.A. Fed. Specn. WWP 541.
I	20.0 Min.	60.0	20.0	—	—	—	—	Ships' fittings, cocks and taps, etc.
J	20.0	57.0	20.0	—	—	Aluminium 3.0	—	Typewriter parts. (Not suitable for pressure castings.)
K	20.0	50.0	25.0	0.5	4.0	—	—	*"Albanoid" pigs.
L	24.0	56.0	13.5	—	3.0	—	1.0 Max.	Motor-vehicle fittings.
M	30.0	53.0	17.0	—	—	—	—	Castings for special purposes.

* "Albanoid" is the registered trade name of Henry Wiggin & Company, Limited.

Nickel

This is, of course, the most important constituent in the nickel-silvers and is responsible for the high corrosion resistance and attractive colour of the alloys. In general it is desirable to specify at least 20 per cent. of nickel to ensure a satisfactory degree of tarnish resistance and a suitable white colour. Lower amounts of nickel than that stated above can be used, but such alloys will have a yellowish tint and corresponding lower order of corrosion resistance.

Zinc

The presence of over 20 per cent. zinc appears to cause shrinkage troubles, particularly so far as sand-cast pressure work is concerned, and consequently this limit should not be exceeded except for special applications, *i.e.*, die-castings and sand-castings where maximum strength and hardness values are desired. High zinc contents are also objectionable from the practical point of view, due to the increased tendency for the evolution of zinc oxide during pouring and the coincident effect of this upon the health of foundry workers. On the other hand, zinc improves the colour of nickel-silver by giving a bluish tinge, which increases the whiteness of the alloys after polishing and also assists to some extent in conferring tarnish resistance.

Considering all factors, a zinc content between 10 and 20 per cent. should meet most foundry applications, using the lower limit for obtaining maximum solidity in pressure castings of awkward and uneven design. So far as the mechanical properties are concerned, increasing the zinc content tends to raise the yield point, maximum strength and hardness and decreases ductility, as will be observed from the values shown in Table II.

TABLE II.—*Mechanical Properties of Typical Sand-Cast Nickel-Silvers obtained in Actual Practice from Compositions given in Table I.*

Mark.	Yield point.	Max. stress.	Elong. on 2 in.	Brinell hardness No.
	Tons per sq. in.			
A. Lead free, 4 per cent. tin.	15.0	22.0	18.0	—
B. 7 per cent. lead, 2.5 per cent. tin.	8.5	15.0	30.0	56
D. High zinc (38 per cent.)	—	35.0	4.0	—
H.	15.0	22.5	15.0	80–120
I.*	—	20.0	30.0	65–86

* = Density 8.72.

Tin

From experience, a small addition of tin has been found desirable in the production of nickel-silver castings, as it seems to ensure denseness, fine grain-structure and increased fluidity. It also has a marked effect on the tensile properties, increasing maximum strength and hardness to a considerable degree. In this respect it is interesting to note that the effect of tin is greater than that of zinc. In nickel-silver alloys containing lead, the presence of a small percentage of tin also materially assists in preventing "lead sweat." For general work it is feasible to allow up to 4 per cent. tin, and around the maximum addition it is extremely probable that tin plays an important part in minimising carbon absorption, this latter factor being, on the whole, undesirable in these alloys, as will be observed later.

Lead

Lead is frequently intentionally present in cast nickel-silvers where ease of machining rather than tensile strength is of primary importance. Whether or not lead helps in the production of sound castings is still a debatable point, but many commercial alloys carry up to 7 per cent. of this element. If this limit is exceeded, "lead sweat" may occur, particularly in heavy-sectioned work, and defective castings will consequently be obtained.

Impurities

Iron is an element to which some attention has recently been given in connection with nickel-silvers; it is, in fact, sometimes used up to 5 per cent. Apart from increasing the tensile strength, it has recently been shown that iron brings out certain characteristics useful in the food-handling industry; for instance, it prevents the accumulation of scum or fog on the surface, although having a general tendency to *decrease the tarnish resistance*. However, for normal purposes, iron is regarded as an impurity to be kept as low as possible, and should preferably not exceed 0.50 per cent.

Sulphur, as in other nickel alloys, should be kept at a minimum, *i.e.*, not more than 0.035 per cent. Silicon and aluminium are detrimental to the production of pressure-tightness in castings, and for normal applications these elements should be absent. For ornamental work, aluminium additions up to 3 per cent. are sometimes made, when the alloy becomes susceptible to heat-treatment. The presence of 0.25 per cent. manganese is a distinct advantage as it de-oxidises the metal and tends to eliminate unsoundness. Magnesium and phosphorus are also often used for de-oxidation purposes, but the amount added should be such as to be entirely consumed by the reaction or, at the most, leave only a trace in the final product. Excess magnesium leads to "dirty" metal, and excess phosphorus causes embrittlement.

Carbon can also be classed as an objectionable impurity, in view of the fact that, under certain circumstances, a reaction may occur between it

* Research and Development Department, The Mond Nickel Company, Limited.

and oxides with the formation of gaseous products and consequent unsoundness. This matter will be outlined in greater detail when discussing causes of unsoundness in nickel-silver castings, but so far as present considerations are concerned, carbon, like sulphur, should be kept at an absolute minimum.

In view of the preceding remarks, the composition range detailed in Table III is recommended as being satisfactory for general foundry purposes.

TABLE III.—*Compositional Range for Cast Nickel-Silver Alloys.*

	General specification. Per cent.	Light castings of even section where max. fluidity is desired. Per cent.	Heavy castings of uneven section. Per cent.
Nickel	18.0 to 22.0	18.0 to 22.0	18.0 to 22.0
Zinc	10.0 to 20.0	15.0 to 20.0	10.0 to 15.0
Tin	2.5 to 4.0	2.5 to 4.0	2.5 to 4.0
Lead	up to 7.0	4.0 to 7.0	4.0 max.
Manganese	up to 0.25	up to 0.25	up to 0.25
Iron plus other impurities	1.0 max.	1.0 max.	1.0 max.
Copper	balance	balance	balance

Melting Equipment

In the melting of nickel-silver, a great deal depends upon the type of furnace used. The best results are most easily obtained with either forced-draft coke-fired or oil-fired units. Nickel-containing non-ferrous alloys are capable of absorbing hydrogen, carbon and sulphur, and in view of these elements having a deleterious effect at one or other stage of foundry operations, it is essential to prevent their absorption by the metal during melting. The success of this depends to a large extent upon the type of furnace available. Other melting units can, if necessary, be employed, such as natural-draft coke-fired furnaces, providing certain factors are taken into consideration.

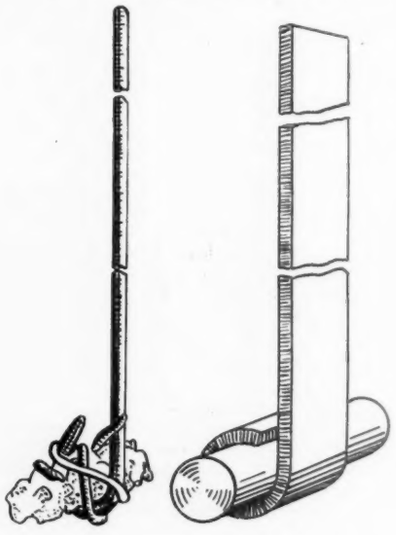


FIG. 1.—METHOD OF ADDING MANGANESE (LEFT) AND MAGNESIUM (RIGHT) TO METAL FOR DE-OXIDATION PURPOSES.

Oil-Fired Furnaces

Oil-fired crucible pit-type furnaces are very suitable for nickel-silver, in view of two factors. First, they are rapid melters, and can bring down a 150-lb. heat in about 1 hour, with the consequent benefit of short exposure of the metal to furnace gases. Secondly, they can be easily operated to give a slightly oxidising atmosphere, containing from 0.2 to 0.8 per cent. free oxygen, which is a further safeguard against the absorption of deleterious gases, such as hydrogen. It is a wise precaution to have the exhaust gases analysed in this latter respect, particularly if the furnace has an exhaust flue connected to a stack or chimney, in order to get some idea of the amount of free oxygen present at any particular setting of the oil or blast valves.

Once a satisfactory setting has been determined, this should not normally require further modification unless a drastic change is made in the type of oil used or a defect develops in the air supply. In regard to this latter point, it is a wise precaution to have a gauge fitted so that this can be checked from time to time.

In open-top furnaces not connected to a chimney flue the presence of free oxygen can be easily observed by the colour of the exhaust flame, which should be transparent yellow with green edge bordering to yellowish-green. The depth of the greenish tints is roughly proportional to the amount of free oxygen present. A fault of this type of furnace is that, due to the absence of an exhaust flue, it is open to the foundry, and the operators will be consequently troubled with zinc fume. Even if the unit is hooded, the results obtained are not nearly so satisfactory as a proper built-in flue connected to a stack, and for this reason the latter is to be preferred wherever possible.

The fuel-oil used should preferably contain not over 0.5 to 1.0 per cent. sulphur, in view of the tendency for nickel-silver to pick up sulphur, but this can be largely counteracted by the use of a suitable flux, such as manganese ore, which is to be preferred to other desulphurising agents, inasmuch as it has little effect upon the life of the crucible.

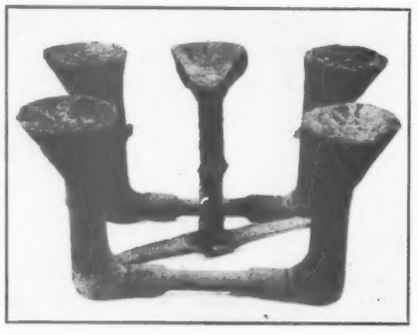


FIG. 2.—RECOMMENDED METHOD OF MAKING TEST-BARS, EMPLOYING CHOKE GATE WITH HEAVY FEEDING RISERS.

The crucibles usually employed are of the ordinary plumbago type, and it is an advantage to use the super high-conductivity grade. In many foundries very economic results are being obtained by using a crucible for a certain number of nickel-silver heats and then transferring to bronze or yellow brass.

As well as oil-fired pit-type crucible furnaces the larger type of tilting furnace can also be used if necessary but for nickel-silver it suffers from several practical disadvantages not present in the former. For example, due to the larger capacity the melting times are prolonged and there is less control over the distribution of the metal when it is ready for casting. The majority of articles made in nickel-silver are relatively small and must be cast over a narrow temperature range in order to obtain the best results, and this cannot be readily arranged with large metal quantities in the average brass foundry. For most applications the average pit-type furnace taking crucibles from 50 to 150 lbs. is hard to beat for general performance. It also has the great advantage of being particularly suitable to foundry production methods in Great Britain.

Forced-Draft Coke-Fired Furnaces

Modern forced-draft coke-fired crucible furnaces are just as suitable for melting nickel-silver as the oil-fired type and have the advantage of being cheaper in operation. They are fast melters and providing that adequate air supply is fitted little difficulty will be experienced in obtaining the necessary slightly oxidising furnace atmosphere. It is, however, advisable to have this latter point checked by analysis wherever possible, as outlined when discussing oil-firing, and also to have a blast-gauge installed for control purposes. A good quality of cut and graded hard furnace coke should be used for melting, containing under 10 per cent. ash and not more than 1 per cent. sulphur.

Most of the coke manufacturers are now supplying furnace coke cut and graded to meet non-ferrous crucible melting furnace requirements and this is of considerable advantage in obtaining uniform conditions, ensuring proper packing of the melting space and longer periods of firing with consequent rapid melting of the charge. A coke size of between $1\frac{1}{4}$ and $2\frac{1}{4}$ in. meets most practical conditions. It is important to use the best hard coke for melting, for the softer grades burn much too rapidly and do not permit of satisfactory conditions being obtained.

FIG. 3.—SHOWING RISE OF METAL IN RUNNER INSTEAD OF SHRINKING, DUE TO DEFECTIVE MELTING AND DE-OXIDATION METHODS.

In melting nickel-silver in this type of furnace it is advisable to ensure that the bulk of the charge is contained in the pot at the start of firing by using if necessary a superheater top or other extension to the crucible. This facilitates rapid melting and also prevents particles of coke getting mixed up with the metal and the consequent risk of carbon absorption. It is also advisable to use a cover on the crucible, and a bottom cut from an old pot is very serviceable in this direction.

Natural-Draft Coke-Fired Furnaces

These furnaces are not nearly so satisfactory as the previous types for melting nickel-silver. They are much slower and usually give a neutral or reducing atmosphere, with the consequent risk of hydrogen, carbon and sulphur pick-up.

They are, however, the unit most commonly employed by the majority of non-ferrous foundries in Great Britain, and if they are to be used certain modification in practice should be considered.

As a melting time of not exceeding one hour is more or less essential for obtaining the best results, the fastest melting fire should be selected for nickel-silver heats and this in most cases will be that nearest to the stack. Care should also be taken to ensure that too large a crucible is not used and that there is ample coke space in the furnace to avoid the necessity for frequent renewal of fuel. If necessary the normal crucible charge can be reduced to obtain the required melting speed. Intelligent application of these suggestions will in most cases provide the rapid melting conditions needed.

The question of correct furnace atmosphere is not so easily solved. Very few natural-draft furnaces give an atmosphere containing a slight amount of free oxygen and the use of an oxidising flux becomes more or less essential. Manganese ore, manganese-dioxide or black copper oxide all evolve a slight amount of oxygen at temperatures over 1,000 deg. C., and these are of great help in obtaining proper melting conditions with this type of furnace. Manganese ore is to be preferred, in view of its additional desulphurising action and low cost, and should be used in an amount equivalent to 3 to 5 per cent. of the metal charge weight. It is important to use a covered crucible in order to maintain the oxidising atmosphere on top of the metal in conjunction with a superheater, as outlined in the case of forced-draft units. The manganese ore should be placed in the bottom of the crucible before charging the metal. If the best results are desired, however, it is well worth while considering the possibility of conversion from natural-draft to forced-draft firing.

Electric melting has so far not been applied in Great Britain to any appreciable extent for the melting of nickel-silver for normal foundry purposes. Melting losses with the arc furnace tend to be excessive, and there is some difficulty in obtaining the correct furnace atmosphere. Furthermore, it does not lend itself to average production routine. Induction furnaces are useful where the metal is to be made continuously, but this is again not common to normal foundry practice, quite apart from the initial high cost of such units. Gas-fired crucible furnaces could be used if the price of this fuel permits.

Composition of Charge

Nickel-silver castings can be made from three types of raw material:—

(1) Virgin metals, pure nickel pellets, best selected copper ingots, tin, lead and zinc, with or without returned scrap from previous melts.

(2) 50 : 50 nickel-copper alloy shot plus best selected copper ingots, tin, lead and zinc, with or without returned scrap from previous melts.

(3) Prepared casting ingots, such as "Albanoid" pigs of definite composition, with or without returned scrap from previous melts.

For those foundries not having metallurgical control the use of prepared casting ingots, together with 30 to 70 per cent. of returned scrap from previous melts, is to be strongly recommended. In the case of mixtures of Types 1 and 2, it is a distinct advantage to add a portion of the tin, lead and zinc in the form of selected Muntz and gunmetal scrap of known analysis, as this facilitates rapid melting and also prevents excessive oxidation. When using natural-draft furnaces, method 3 is more or less essential, and is to be particularly recommended for the production of pressure-resisting castings regardless of the type of furnace employed.

Melting Procedure

Where light castings are to be made, small-sized crucibles should be selected as far as possible, so that adequate control can be obtained over pouring conditions. Nickel-silver should be poured relatively hot, and if a large crucible is used to cast a great number of moulds, the temperature drop between the commencement and finish of pouring is outside the range essential for obtaining satisfactory results. This point requires additional emphasis when using super crucibles, as, in view of their high heat conductivity, they cool more rapidly than the normal plumbago pot.

It is also advisable to use a superheater on top of the crucible, so that the bulk of the metal charge can be included at the commencement of melting. During melting the top of the crucible or superheater should be covered. This latter statement is of particular importance when using coke firing in order to prevent fuel entering. *Charcoal should not be used on top of the metal.* The best method of protecting the melt is to use an oxidising and desulphurising slag, such as manganese ore, in conjunction with a covered pot. This flux is to be strongly recommended as a safeguard, quite apart from the type of furnace used.

To make a melt of nickel-silver from a charge conforming to either Type 1 or 2 the following procedure should be adopted:—

(*a*) Manganese ore at bottom of crucible (3 to 5 per cent. of metal charge).

(*b*) Now add nickel pellets or 50/50 nickel-copper shot.

(*c*) Next add copper ingots. (Copper scrap should not be used.)

(*d*) Add part of the zinc if virgin metal, or all Muntz metal scrap. (The latter is to be preferred.)

(*e*) Complete charging with gunmetal scrap and returns from previous melts.

Cover crucible as previously outlined and melt as rapidly as possible to an adequate superheat.

(*f*) Now add remainder of zinc if Muntz scrap not used initially, or sufficient amount of zinc to balance composition if latter is used. Stir melt.

(*g*) Add lead and tin if necessary, stir in thoroughly and hold for a few minutes.

(*h*) De-oxidise.

It will be found that if it is possible to use approved Muntz or gunmetal scrap to make part or all of the zinc, lead and tin additions, melting procedure is considerably simplified.

To make a melt using prepared ingots, place the necessary amount of manganese ore in the bottom of the crucible as before, add the ingots and returned scrap from previous melts, cover the pot and melt as rapidly as possible to an adequate superheat. A small amount of zinc should be added to cover melting loss (½ to 1 lb. per 100 lbs. of metal), and then de-oxidise.

Nickel-silver swarf and borings returned from the machine shops should be remelted, pigged and analysed before being reused.

De-oxidation

A few foundries are successfully producing nickel-silver castings for both ornamental and pressure-resisting purposes without conducting any de-oxidation treatment whatsoever, but they are the exception rather than the rule. At first sight one would think that the zinc in the alloy

HIGH-PRESSURE RELIEF VALVE BODY.

DOMESTIC TAP BODIES (GLENFIELD & KENNEDY, LIMITED).

MISCELLANEOUS VALVE FITTINGS (GUMMERS, LIMITED).

VOICE PIPE FITTINGS (R. BLACKETT CHARLTON & COMPANY, LIMITED).

FIG. 4.—GROUPS OF CASTINGS SHOWING SUCCESSFUL MOULDING METHODS USED FOR CASTING NICKEL-SILVERS.

would act as a natural de-oxidiser, and this is partially true under certain conditions of composition and melting procedure. In the majority of cases, however, de-oxidation is a necessary precaution for obtaining the most economical results. Additions of magnesium (½ to 1 oz. per 100 lbs. metal) or manganese (1 to 1½ ozs. per 100 lbs. metal) are often used for this purpose, but if the best results are to be obtained the de-oxidation treatment given in Table IV is recommended.

In de-oxidising melts in pit furnaces covered with manganese-ore slag, the manganese should be bound to the bottom of a steel rod with copper wire, as shown in Fig. 1, and plunged to the bottom of the crucible at least 5 minutes before drawing from the furnace. The magnesium addition should be similarly made immediately before drawing the crucible. The phosphor copper is added immediately before pouring and after the protective slag has been removed. This latter addition can be omitted if desired, but it is sometimes useful in clearing up the surface of the melt and facilitates pouring. The whole de-oxidation treatment as recommended has been found to work well on 150-lb. heats made in an oil-fired crucible pit furnace from virgin metals, pressure-tight castings being readily secured on rather difficult patterns.

TABLE IV.—*Recommended De-oxidation Procedure.*

De-oxidiser.	Form.	Ozs. per 100 lbs. metal.	Time of addition before pouring.
0.10 per cent. Mn.	97 per cent. manganese metal	1½	5 to 7 minutes
0.05 per cent. Mg.	Magnesium stick	¾	3 to 5 minutes.
0.02 per cent. P.	15 per cent. phosphor copper	2	Just before pouring (optional).

When prepared ingot is used or a considerable portion of the charge is composed of returned scrap, a simple de-oxidation with either manganese or magnesium will probably suffice. De-oxidisers other than those stated above, particularly silicon, should not be used as additions to nickel-silver.

Pouring

Before withdrawing the crucible from the furnace the metal should be amply superheated to at least 1,400 deg. C.—the metal freely evolving zinc fume. Immediately after withdrawing, the slag should be thickened if necessary by the addition of powdered lime (CaO), well skimmed from the *opposite side to the pouring lip*, and the metal poured hot into the moulds. The correct pouring temperature depends upon the size, section and composition of the castings being produced. Generally speaking the temperature employed for ordinary cocks and taps will vary from 1,250 to 1,350 deg. C. but little trouble will be experienced if one casts, within reason, as hot as possible. In the case of test-bars for inspection purposes it is advisable to find the most suitable casting temperature by experiment and to use running methods as shown in Fig. 2.

The gate should be choked as quickly as possible on starting to pour, and be kept full throughout the entire pouring operation, filling the moulds fairly rapidly. In general, horizontal pouring is preferable for most work. The appearance of the top of the runner or risers gives a good indication as to whether melting and feeding have been satisfactorily conducted, and they should show a pronounced shrink. If the metal rises in the runner at, or just prior, to solidification, as shown in Fig. 3, it can be assumed that melting or de-oxidation practice has been defective and the castings will be porous.

Moulding

In moulding there is no general rule to be followed, as every pattern is a problem in itself. Nickel-silver has a shrinkage of around $\frac{3}{16}$ in. to the foot, which is similar to that obtained on cast yellow brasses and bronzes used for plumbing fixtures, valves, taps, etc. Accordingly one can anticipate that in many cases *well-designed* pattern-plates as used for casting the above can be turned over to nickel-silver without much alteration, providing the runner can be choked during pouring as previously recommended. It is, however, a wise precaution to keep runners and risers of ample proportions, particularly so far as the larger and uneven sectioned castings are concerned.

FIG. 5.—BLOWHOLES IN NICKEL-SILVER CASTING, DUE TO FAULTY MELTING AND DE-OXIDATION METHODS.

Some information of bearing on the question of liquid shrinkage is shown in Table V, from which it will be observed that the total volume shrinkage of nickel-silver is somewhat greater than valve bronze. Fig. 4 gives a general indication of successful moulding methods used in practice for various types of castings.

TABLE V.—*Shrinkage of Nickel-Silver.**

Alloy.	Composition, per cent.					Total volume shrinkage. Per cent.	Linear shrinkage. Per cent.	Freezing shrinkage. Per cent.	Contraction. In. per ft.	Pattern-makers' allowance. In. per ft.
	Cu.	Ni.	Zn.	Sn.	Pb.					
Nickel-silver ..	65	20	15	—	—	12.1	2.19	5.5	0.17	$\frac{3}{16}$
Nickel-silver ..	56	20	15	4	5	12.1	1.88	6.5	0.13	$\frac{1}{8}$
Valve bronze ..	85	—	5	5	5	10.8	1.44	6.5	0.16	$\frac{3}{16}$

* "Physical and Casting Properties of the Nickel Silvers." Kihlgren, Pilling and Wise. Trans. Am. Inst. Min. and Met. Engrs. (Inst. Metals Div.), 1935, cxvii, pp. 279–309. Disc. 309–312.

In general, risers should be placed so that they will be filled with the hottest metal at the end of the pour, and nickel-silver should not be expected to run a pattern-plate containing quite so many pieces per gate as commonly used for the more fluid bronzes. In view of the higher temperatures involved, nickel-silver has greater chilling tendencies and one cannot therefore expect it to run certain moulds as well as the lower melting alloys. Moulds should be filled rapidly without excessive turbulence. In practice possibly the best course to adopt is to work at first by trial and error methods, making the necessary alterations as and when required according to results obtained.

Moulding Sands

In view of the high casting temperatures employed, it is important to use refractory and permeable sands. Small nickel-silver castings can be readily made in green sand using the natural red sands of the Bunter group so favoured for brass foundry purposes, such as Mansfield, Belfast and others. Some of these sands are supplied in various grades of texture, and the finest grades should be avoided. This particularly applies to Belfast deposits, used extensively in Scotland, as this source has proved rather variable during the past few years. Dusting the mould face with pease meal or flour helps in obtaining fine finish, and skin drying is an advantage.

In the production of larger castings, dry sand should be used in conjunction with a suitable protective black-wash, but precautions should be taken to ensure that the strength of the sand is not unduly high. Table VI outlines recommended properties for sands used in the production of nickel-silver castings. *All moulds should be well vented by artificial means.*

Core Sands

Core practice on nickel-silver should follow the lines of ordinary bronze practice, and no special suggestions are required. Oil sands are quite frequently used for mass-production purposes, and are usually made from sea sand to which a certain amount of fine silica or red sand has been added to give the necessary finish in conjunction with one or other of the many organic binders on the market. In most cases the cores should be soft and collapsible, especially on work where the cores are large and the metal sections light. Not infrequently trouble has been caused by the resistance to shrinkage which is imposed on the metal during solidification and cooling by too hard cores. Care should be taken to ensure adequate permeability.

Defects in Nickel-Silver

If the main points as outlined in this article are followed, little difficulty should be experienced from unsound castings. An intelligent foundryman is quite capable of dealing with the more obvious troubles which may arise, but there is one defect which may puzzle the practical worker, namely, that shown in Fig. 5. Unsoundness takes the form of numerous small bright blowholes disclosed as soon as the skin is broken during machining or polishing, and is due to improper melting or incomplete de-oxidation treatment.

If a reducing atmosphere be employed and melting be prolonged, the metal absorbs both hydrogen and carbon to a variable extent. On cooling, the metal gives off hydrogen, and this can contribute to the formation of this defect. An alternative cause is due to the fact that under certain circumstances carbon will react with oxide to form carbon-monoxide, a gas which is very soluble in molten nickel-containing non-ferrous alloys, but which is much less soluble in the solidifying metal. The result of this is that the gas is liberated on solidification and causes the bright blowholes and porosity in conjunction with the rise of metal in the runner, as illustrated in Fig. 3. The remedy is to melt under oxidising conditions, followed by adequate de-oxidation treatment. Sand which is too damp or impermeable moulds will also cause blowholes, but if due to these causes, the metal will blow as soon as it enters the mould, but this disturbance, as a rule, has little effect on the observable shrinkage shown on top of the runners and risers.

TABLE VI.—*Properties of Moulding Sand for the Production of Nickel-Silver Castings.*

Property.	Green sand for light work.	Dry sand for medium and heavy work.
Moisture, per cent. ..	6 to 7	7 to 9
Green compression, A.F.A., lbs. per sq. in.	4 to 5	4 to 5
Dried compression, A.F.A., lbs. per sq. in.	at least 40	80 to 120
Permeability, A.F.A., No.	40	60

(*Concluded on page* 161.)

Time and Motion Study in the Foundry

DISCUSSION OF MR. C. D. POLLARD'S PAPER

Mr. C. D. Pollard's Paper on "Time and Motion Study in the Foundry," which has appeared in instalments in the last four issues of the JOURNAL, provoked the keenest interest among members of the Sheffield Branch of the Institute of British Foundrymen. Following its presentation at the Branch meeting last month, a lengthy discussion took place which touched on many phases of the subject.

DISCUSSION

The BRANCH-PRESIDENT (Mr. J. B. Allan), opening the discussion, said that the system of which Mr. Pollard had given a detailed description appeared very complicated, but it was probable, when one knew more about it, that it would prove much simpler. He was particularly interested to learn that the system, or a large part of it, had been in operation for such a long time. He thought that was rather unusual; it had started from the very basis, with the time it took to lift a shovel and put it back again, as long ago as 1916. Probably that fact had much to do with the success of the Qualcast concern. He asked what type of people the investigators were —whether skilled moulders or clerks. Obviously, as the figures they produced were the very basis, they must be very trustworthy and reliable.

The Case of the Jobbing Foundry

MR. J. ROXBURGH said the author's outline of the system he had for tackling sales from the estimates to the orders was very much on the lines that others practised in the industry. Mr. Pollard's ideas with regard to the settling of prices and the creation of confidence between management and men were very praiseworthy, as was the realisation that they were in business to produce first-class castings at an economic price. The figures and other information disclosed apparently dealt in the main with repetition work in a mechanised plant; naturally, under those conditions both scientific control and the obtaining of statistics were very much easier than in other types of foundries. Actually, they represented the ideal conditions under which one could obtain those statistics. Probably the members had all had experience of repetition work, and from that standpoint investigations such as the one described were both necessary and useful. In a jobbing foundry craftsmanship was of the highest importance, and in dealing with the human element a tremendous difference was found in the speed of working of the various operators; he knew from experience that it took one set of men on a particular job a real effort to make time and a quarter, whilst another set of men would make double time. In such cases times had to be based on the "average moulder," and that was difficult to do at times, because the men all asserted they were average moulders.

Yet even in a jobbing foundry the management went into each detail as far as was practicable at the estimating stage, and again at the stage of setting the price. They estimated so many hours for ramming, jointing, ramming the top, finishing and closing, and they based the piecework price accordingly. The rate fixer, for his own and for the firm's benefit, naturally took as many records as possible for reference, so that when an entirely new job came along, he was able, from his experience, records and references, to make a fairly accurate estimate of how long the job would take.

Estimates

When an inquiry was received, naturally it first went through the channels in the office and then was sent to the foundry manager. Particularly in a jobbing foundry, where it was possible to make a job four or five different ways, it was the duty of the foundry manager and his staff to devise the best and cheapest way of doing that job, and then to co-operate with the pattern-shop in the making of the tackle and deciding on the method which was to be employed, so that when the order came along, it was processed in the same manner and a definite method was devised for doing the job. In addition, when the job had been made, records were kept of the method employed and any particulars which would be of use for the future. The nature, sizes and position of the runners and risers, the mixture of the metal, and various operations on the job were obviously recorded. From that standpoint, a jobbing foundry to a certain extent kept particulars of the various operations. Where mechanised plant was used in a jobbing foundry, naturally they were able to get nearer to their figures where they used a sand or a moulding machine of some sort, and in that way as many records were kept as possible because, in addition to experience, they had got those facts and figures before them to guide them on any particular job which might come in.

MR. C. D. POLLARD said it was probably surprising to people who had not come into contact with the works to know the system had been working so long. It was started by six people more than 17 years ago, and to-day the system was operated by the right-hand man of the creator (Major Briggs) of the scheme, together with an assistant, a youth, and a typist. Since the production of Qualcast was of the order of 65 tons of cupola metal daily, and the largest casting would go in a box which two men could lift, it would be seen the system was not overloaded by staff. Those operating the system were not skilled moulders, and they might not know whether a certain runner would give a good casting, but they knew from their experience and references and knowledge that so many patterns in a box with certain types of runners would do the job. It was the foundry manager's job to decide, but they gave the lead in the direction of thinking out the cheapest way of doing the job.

Mr. Roxburgh had said it might be easier to work the scheme in conjunction with repetition work. He (the author) would say that repetition work lent itself to the system, but the possibilities of such control extended into the realms of a far wider field, and it was for the executive of a foundry either to re-organise or redesign the foundry, knowing what it meant to apply time and motion study methods. He had seen in his short contact with the scheme the possibilities of jobbing foundries controlling the smaller and some of the medium-sized castings prduced from their moulding machines far more economically. It was obvious that foundrymen in estimating got as much detail as they could, but the more positive figures they secured from such a scheme where the analysis of the operations brought them down to operations which took two or three seconds was very much more satisfactory from a price-controlling point of view, and coupling up production costs against estimate when they embraced so much detail. It did give the foundry manager a confident feeling whilst he was in production.

Overhead Adjustment Figures

MR. T. R. WALKER said he noticed that the charts of operations were most carefully timed to fractions of seconds, but on the estimates there were some figures of bonus of 50 per cent. of something. Were those comparable in accuracy with the fractions of seconds, and where did they come from? Was it the foundry manager's business to fix these, or were they from the investigator or from the costs office? He presumed some of them referred to overheads. Were they subject to alterations?

MR. POLLARD said he had explained that all the figures were fictitious, and naturally when they were putting representative figures down for bonus and overheads they put down round figures. The system allowed the accountant to take out his costs weekly. The overheads, if the accountant thought fit, did fluctuate weekly. The foundry manager took the figures from the operation sheet as given during the day's work, so they knew from every job whether the standard was 100 per cent. or 110 per cent. From the records of daily production the accountant got out his figures of production, and the necessary knowledge was ready for him as to whether his overheads were being absorbed, over-absorbed, or under-absorbed, thus giving him an opportunity of adjusting his overhead figures weekly. He did not say they were done weekly, but they were certainly done monthly.

MR. WALKER thought that if the overheads were to vary week by week it must be difficult to get out an exact estimate.

MR. POLLARD pointed out that he did not say they varied weekly, but "if they did."

No Direct Interference

MR. HARRISON asked if the investigator dealt directly with the man, in case of discrepancy, or through the foreman.

MR. POLLARD replied that there was always a trio. The foundry manager, the investigator, and the operator were always in the discussion. There was no such thing as an investigator going to a machine and interfering with an operator without the foundry manager or one of his assistants being on the job. An operator could complain about any operation in standard time or anything in connection with piecework prices through his foreman, and through the foreman the piecework investigator went on to the job.

Unlimited Production

MR. F. SMITH said that one card showed that the cost of moulding was highest in the case of the man who worked the quickest. The extra cost might be only a penny, but a penny on hundreds of castings mounted up. Was not there a limit to the procedure whereby it paid the firm to let a man make his work dearer because he made more?

MR. POLLARD replied that no limits were put on anything. It would be realised that, with the very careful analysis that was taken during time study, the net time for all the operations in the aggregate did give a fairly accurate time that it would take to make the mould. It could fluctuate slightly, but the system was such that a man could work continuously and earn proportionately, and everybody was satisfied. There was no limit at all; the more the men did, the more the firm were satisfied. The price per article went up, but that did not influence their cost, because they had to balance the piecework price and the quantity made and the overheads, and they balanced one another.

Manual Dexterity Eliminated

MR. F. WILLIAMS said the object of using piecework, as he saw it, was to take advantage of the difference in the manual dexterity of the operators. If the time study system was properly and logically applied it seemed to him that manual dexterity went by the board and there should be no need for a piecework system. If they ever had need for a piecework system how far did they apply standard costs as opposed to the detailed job? With regard to bonus earnings, the cost of 104 castings produced by the man who made most was 9.29d., whilst the cost of 94 was 9d. each. How were the overheads applied in that case?

MR. POLLARD reiterated that it had not been his intention to approach the subject purely as a costing system, and it would be folly for him to attempt to detail how the overheads were

distributed and allocated day by day, but the knowledge of the accountancy side of the system was equal to the knowledge of the application of it in the shops, and they had sufficient confidence in the accountant to adjust those figures in order to satisfy whoever was in control of the works. Regarding the men's dexterity, if they timed all the good men and then put second-rate men on, and the production fell, they would meet the serious problem of the overheads not being absorbed. They had specialist jobs on which they had to put fairly skilled men. Once the jobs were timed with men of that class they were not given to second-rate men; they had to make good castings.

Group System

MR. ROXBURGH said his firm had piecework for moulders and coremakers. In their system, if the job was made by one man so much quicker than by another man, they got the benefit of that and their overheads were based on the actual working hours. If one set of men made a job in 50 hours and another set of men made it in 75 hours, the overheads were based on the actual hours taken, and the bonus earned was added on. Therefore, it paid the firm for a man to make time and a half on a job rather than time and a quarter. If they produced more, the firm were producing cheaper.

"Paper Costs"

DR. C. J. DADSWELL said that if the piecework price appeared high, the paper cost of the job would be more, because it was based on the overhead charge which had been established for a week, month, or six months. The actual costs of jobs were not paper costs; the paper costs were only to get some idea. The actual cost depended on the number of the castings which were produced in an hour, or in a week, as against the indirect charges of capital cost of machines, the indirect charges of the man's sand handling, and so forth, which one did not change into an overhead figure varying from week to week. They in Sheffield were not mass producers of castings. They had probably attempted in a very primitive manner some sort of time studies, but they had not been familiar with the systems or processes by which they had been applied in real quantity-production foundries such as the one with which Mr. Pollard was connected. He thought they had all learnt something in that respect, and that was the manner in which it could be simply applied with a small staff. If it was applied at places where there was a bigger variety of work, it would be necessary to have a much larger staff. In jobbing foundries where they had little bits of production going on to some extent, he did not see why a system like the one described could not be applied. It might not be worth the cost of putting it in quite the detail that was shown, but even if one timed the larger groups of operation, one would obtain some sort of economy and greater efficiency. He noticed one or two smiles at the mention of shovelling. He thought that the timing of shovelling was one of the very first things that was applied, which really was the fore-runner. Mr. Tabor in America was the first man to study the time of shovelling, and also the size of the shovel which gave the most efficient shovelling. The Derby foundry had apparently started from the basis and worked upwards, because shovelling in the foundry was, perhaps, one of the most common manual operations.

MR. POLLARD said he was pleased to hear those remarks, because when one began to prepare a Paper such as he had done, one could only hope it would lead somebody into a new line of thought or help him to develop some ideas he might have. As most of them knew, he had spent much time in Sheffield and probably with many people saw the difficulties of applying such a scheme, but it was astounding when one was in contact with it how easy one could find help whilst he was doing his job in the shop. With regard to shovelling, he had picked out something which was easy to speak about. There might be 200,000 reference cards, and about 17 years ago there were 70,000, he thought. They were so easily indexed and filed and logged that they could have all the information they wanted almost instantaneously. That might sound a little exaggerated, but it was a fact, and it was because people had started at the bottom and developed the scheme step by step.

Patternshop Organisation

MR. G. OFFILER asked if the card index system was in vogue in the patternshop to any extent. Was there an investigator in the patternshop and, if so, what type of man was he?

MR. POLLARD replied that the patternshop was never time-studied at all. The instructions were so definite on the lay-out sheet. The patternmaker knew exactly what to do, and the question of timing him was never entered into at all.

Perfect Patterns

MR. WHARTON asked if the system could be related to the firm that worked only to the finest patterns it was possible to make. Mr. Pollard had said it could be extended to jobbing foundries. Did he see the possibility of working with any sort of pattern or patterns which were not quite as good as he worked with himself?

MR. POLLARD said the object of machine moulding, apart from speed and cheapness, was to get perfect moulds. If an operator had a pattern plant which caused him difficulty he could refuse to make another mould. It would be realised, therefore, that they did put good pattern plant in. If they set a standard of so many a day, it was set on the assumption that the man could get on with the job. If the operator had any cause to complain about his pattern plant he definitely was entitled to refuse to work, and the manager decided whether it was justified.

A MEMBER asked if there was any allowance on the estimated time for bad castings. At the conclusion of the day's work, who had to decide who was at fault for bad castings? Was the man paid for bad castings, and had he to replace them at the original rate?

MR. POLLARD said there was always an estimate for customers' rejects; it was always definitely put on the estimate sheets. The shop waste was also estimated by everybody concerned. Naturally, the foundry manager was the man who had the responsibility and authority for putting those figures, but those two items, their own scrap and customers' rejects, were always taken care of in estimating. As the castings were knocked out they went through to the fettling shop, and the doubtful castings were picked out for inspection by the foundry manager. It was definitely his duty to say which castings were to be paid for and which were not.

Accuracy of Estimates

MR. F. WHITEHOUSE said he was interested in scientific production. He had not quite got the point of the motion study, whether it meant that the production was scientific or whether it was a scientific means of getting more out of a man. Were they increasing the skill of a man by cutting out unnecessary operations, or were they hurrying him along in the operations he did? Could Mr. Pollard indicate to what degree of accuracy the estimating was done? Could the estimating department give a very close figure to actual costs, even in the estimating stage, or were they rather like foundry managers who said, "We rather think there will be 80 boxes produced to-day, but we will reckon on 70"? To how fine a degree of accuracy could the estimating department work?

MR. POLLARD recalled that he had said, "It must be the duty of the time and motion study men to feed the foundry manager and his assistants with all the available information regarding the cheapest method of doing any job or operation, but at the commencement, *i.e.*, at the estimating stage, this factor must not be allowed to jeopardise the production of good castings." The time and motion study man, because of the information he had tabulated and recorded, could say that so many patterns would go in a certain sized box, with a certain sized runner, etc. If the foundry manager objected to the figures, then the time and motion study man said, "The next cheapest is so and so." None of the factors of time study must interfere with or jeopardise the production of good castings.

MR. WHITEHOUSE asked in what way was the firm training better men by the time and motion study method than were being trained elsewhere.

MR. POLLARD replied that scientific production was always taken care of by the foundry manager. It was his responsibility to make castings, whatever hints he might get from the time and motion study people. He had always to keep in mind that he had to produce good castings. Scientific production hand in hand with the scientific investigator made it easy for the man to do the job for which he was employed. The investigator was not there to hurry the men; if a man was making a mould, he carried on in a normal way. The investigator's work was to stand on the job and investigate those things which he thought were preventing quick production, but not to interfere with a man's speed of work. He was there to offer facilities by the removal of unnecessary work and offer facilities for easy movement.

Mr. Pollard, continuing, said he could not illustrate the question of accuracy of estimating better than by referring to the fine analysis to which estimating was taken. In beginning an estimate, the investigators made a survey and put down the sequence of operations which they knew from their records should be necessary for making up that type of mould. The foundry manager went through the operations, and if he thought there were any missing or any redundant, he added or took away, which meant that the estimating, by virtue of such fine analysis, was as fine as it could be. That analysis of the estimating was put down on the observation sheet and was transferred to the instruction card, which went in when the job went into work, and the man's and the investigator's work gave on the instruction card operation for operation as it was laid down in estimating. Thus they got a parallel between production and estimating.

MR. B. GRAY said he thought the last question could be answered by the case of the rapid production of machine tools. From a study of the quick worker and the slow worker it was found that the loss of time by the slow worker was almost entirely due to inefficient and wasteful actions. It could be truly said that the scientific method could improve an indifferent worker. They could see him make all sorts of actions which dissipated his strength and slowed him up. Mr. Gray observed how refreshing it was to hear a detailed description of a foundry which was being run on those lines. It was quite evident that Qualcast had something to teach all of them on the subject. He could not help asking the question whether Major Briggs studied policy very ingeniously when he used a 14-in. shovel instead of a 12-in. shovel, which was bound to increase output by 20 per cent.

MR. POLLARD said he was afraid he was one of the neophytes at Qualcast, but no doubt the commencement of the scheme was based on such study. The shovels at Qualcast were of standard size, except when they came to cupolas, when they could have what size they liked.

MR. WHITEHOUSE asked whether Qualcast tried to govern where a man should move his shovel, the place where it stood, and the exact height of the box he was filling.

MR. POLLARD replied that that was part of the organisation; it definitely was the basis of the scheme. If they did not standardise and pay very careful attention to such details it was useless keeping an investigator.

Sand Standardisation

MR. T. R. WALKER said that, if everything was standardised in a standardised foundry, he presumed the sand was standardised. Did the author have regular examinations of the sand to ensure it was the same always? He would have to standardise the core compound and the core sand to give the same degree of workability, and everything correspondingly.

MR. POLLARD replied that sand control was carefully handled, but not to the same extent as in some foundries. The facing sand was very carefully handled and mixed, and so with the core compound. Regarding the backing sand, the night men who did the knocking out of the castings were paid approximately so much per cubic foot of sand. They had so many moulds of a certain size from a machine and they knew within very fine limits that the same quantity of sand would come off that machine every day. The moistening was not done in a scientific way, but it was controlled by the quantity of water added to so much sand per night.

Replacement Problems

MR. J. C. JONES asked if the system tended to segregate workmen into first-class skilled operators. When the supply of first-class skilled men ran out, would the second class of operators enter, or would they have to adjust their standards to the second-class scale?

MR. POLLARD said it would be realised that when they had upwards of 200 machines working every day they had quite a number of first-class machine moulders. They were skilled in their own particular sphere. There was no difficulty in replacing one or half a dozen men with such a number of machines. If they had only 30 machines, then the problem might present itself.

Advantages Summarised

The PRESIDENT said it was perfectly certain that even in a purely jobbing foundry the regular and scientific collection of data and the proper analysis of that data must, in the end, assist very much in the efficient running of a foundry. Generally, he was rather afraid, there was a tendency for those in the jobbing shop to take the view that the collection of data was unnecessary, and that they could not make use of it if they had it. He did not think that was true at all, because over a period of months or years they were certain to come across jobs which had many points of similarity, and the points of one they could apply to some extent to another. Probably Mr. Pollard's Paper had made them think of the possibility of applying something even in a very small way to running a particular job, and he was pretty sure it could be applied to almost any. One very happy result of the arrangement, certainly to Mr. Pollard, must be the availability of costs in a day. If they could get the costs of work of the previous day on the following morning they could make very good use of them. Mr. Whitehouse had asked some very interesting questions, he thought. Surely if they wanted to get the best out of the men they wanted to make it as easy as possible for them to do their work, and the shovel business was the best way to do it. For any skilled man, whether he was skilled in the term that was generally used or a skilled man such as applied to Mr. Pollard's establishment, the less shovelling he had to do, and the less stooping and turning round he had to do, obviously were going to improve output and production. Certainly, careful thought and motion study, because that was what it was, must help enormously.

Vote of Thanks

MR. ROXBURGH said it gave him great pleasure to propose a hearty vote of thanks to Mr. Pollard for giving them such an interesting lecture and one which had given rise to one of the most interesting discussions they had had at that Branch. He thought, too, that the attendance was splendid, and it was a tribute to Mr. Pollard, and he was sure none of them had been disappointed. He had had experience of repetition and semi-repetition work, and in the jobbing foundry they made a point of collecting data and keeping as many records as possible. But, as Mr. Pollard had admitted, their estimates were very accurate indeed and they accorded with the time taken. When they came to a jobbing foundry, competing on the open market, he was a good man who could get within a few hours of his estimating. When they manufactured jobs taking 2,000 hrs. he was a very good man, despite all the records he had, if he could get to a degree of accuracy commensurate with what Mr. Pollard had shown them. But with experience and the collection of data they were gradually improving in the jobbing foundry.

MR. WHARTON seconded the vote of thanks, which was carried.

MR. POLLARD, in acknowledgment, said that if his address had given them pleasure and created any thoughts of giving attention to some of their costs, he was very well recompensed.

Catalogue Received

Bentonite. The District Chemical Company, Limited, 52/54, Leadenhall Street, London, E.C.3, have sent us an eight-page pamphlet which sets out the use of the mineral Bentonite for bonding moulding sands. It first details the potentialities of the material, which are now well established, and then enlarges upon its use for various phases of foundry practice. The last three pages are devoted to the setting out of recipes for facing sands for grey iron, malleable and steel, and core mixtures to include both linseed and dry compounds.

There is a wealth of extremely useful information included, such as the amount of moisture to carry in each case, whilst the Bentonite additions are set out for most types of foundry requirements. This piece of publicity matter is extremely useful for any foundry executive to possess, and is available to our readers on request to the issuing company.

The Casting of Nickel-Silver for Foundry Purposes

(*Concluded from page* 158.)

On the other hand, if due to gas evolution from the metal itself, no violent disturbance occurs, and the metal rises slowly and gradually around solidification point, as illustrated in Fig. 3.

Summary

The following summarises the main points which should be borne in mind in order to ensure sound castings in nickel silver:—

(1) Use raw material of adequate purity and appropriate composition.

(2) Melt rapidly under slightly oxidising conditions.

(3) Do not use charcoal as a cover. Use manganese ore instead.

(4) De-oxidise properly.

(5) Pour at sufficiently high temperature.

(6) Fill moulds rapidly, but without excessive turbulence.

(7) Use ample and properly placed gates and risers.

(8) Use open sand and vent moulds thoroughly.

(9) Use moderately soft cores which collapse readily.

A New Calendar

We acknowledge with sincere thanks the receipt of a monthly tear-off wall calendar carrying a picture of a "leggy" young "glamour girl," from Richards (Leicester), Limited, Phœnix Iron Works, Leicester.

The Foundry Institute of the Aachen Technical High School

SEVENTH WINTER SYMPOSIUM

The seventh winter symposium of the Foundry Institute of the Aachen Technical High School is to be held in the large hall of the Neuman Institute, No. 1 Intzestrasse, Aachen, from February 24 to 26. The first session is to be a joint meeting with the Materials Committee of the Aluminium Board of Berlin and the School. The following programme will be followed.

THURSDAY, FEBRUARY 24.

10 a.m.—Opening of the Symposium by the Rector, Dr. Buntru, and the Director, Prof. E. Piwowarsky. The following Papers will then be presented:—

"Crystallisation Phenomena in the Alpax Group of Alloys," by E. Piwowarsky and Dr. H. Nipper.

"Structure of Castings and Fatigue Strength of Some Aluminium Alloys," by Dr. E. Böhm.

"Investigations into the Fatigue Strength of Alloys of the Alpax Group," by Ing. G. Guertler and E. Schmid.

"Impressions of American Foundry Practice," by Dr. Nipper.

1.15 p.m.—Informal luncheon.

3.15 to 6.15 p.m.—The following Papers will be presented:—

"Contraction and Shrinkage of Aluminium Alloys," by Dr. L. Herrmann.

"Casting Stresses in Aluminium Castings," by Dr. P. Schneider.

"Aluminium Foundry Practice," by Oberingenieur Mertens.

"High-grade Aluminium Alloys for Anodising," by Dr. G. Seumel.

Should time permit, discussion will be taken on the Papers.

FRIDAY, FEBRUARY 25.

The session will take the form of a joint meeting between the German Foundrymen's Technical Association (associated with the Political Board) and the School. In the morning the Papers for presentation are listed as follow:—

"Recent Progress in Zinc Alloys," by Dr. A. Burkhardt.

"Melting Practice for Magnesium Alloys," by Ing. K. Achenbach.

"Chrome Steel Castings," by Dr. K. Roesch.

"Recent Results from the Testing Laboratory of Meier & Weichelt," by Dr. F. Roll.

"Influence of Lead on the Properties of Cast Iron," by Dr. H. Bruhn.

1 p.m.—Luncheon.

The Papers listed for presentation in the afternoon are:—

"Grey Iron as a High-Strength Structural Material," by Dr. R. Bertschinger.

"New Research Results on the Theoretical and Practical Importance of the Graphite Formation in Cast Iron," by Prof. Piwowarsky.

"A *Résumé* of Current Research Work being undertaken at the Institute," by Ing. W. Patterson.

"Cupola Practice," by Dr. H. Jungbluth.

7.30 p.m.—Social evening at the Quellenhof (The Hydro). Morning dress.

SATURDAY, FEBRUARY 26.

The following Papers will be discussed in the morning:—

"Foundry Practice Comparisons," by Dr. Th. Geilenkirchen.

"The Organisation of the Staff in Industry," by Dr. W. Baurmann.

"American Visit," by Dr. Nipper, Prof. Piwowarsky and J. H. Kuster.

1 p.m.—Close of Symposium.

1.30 p.m.—Informal luncheon.

An invitation to attend would, we believe, be extended to British foundry executives on application to Prof. Piwowarsky at the Aachen Technical High School.

Institute of British Foundrymen

LANCASHIRE BRANCH DINNER

The annual dinner of the Lancashire Branch of the Institute of British Foundrymen, over which Mr. R. A. Jones presided, took place at the Grand Hotel, Manchester, on February 5. Among those present were Mr. C. W. Bigg (President of the Institute) and Mrs. Bigg; Mr. F. O. L. Chorlton (President, Manchester Association of Engineers); Mr. R. W. Stubbs (Chairman, Manchester and District Ironfounders' Employers' Association, and Past-President of the Institute) and Mrs. Stubbs; Mr. H. V. Grundy (Senior Vice-President of the Lancashire Branch) and Mrs. Grundy; Mr. F. D. Webb (Secretary, Manchester and District Ironfounders' Employers' Association) and Mrs. Webb; the Mayor of Swinton and Pendlebury, Alderman Mycock, and the Mayoress, Mrs. Mycock; Mr. L. Herbert (President of the Manchester Metallurgical Society) and Mrs. Herbert; Mr. T. Makemson (Secretary of the Institute); Mr. J. E. Cooke (Hon. Secretary and treasurer of the Lancashire Branch) and Mrs. Cooke; and Mr. A. L. Key (Junior Vice-President of the Lancashire Branch).

Prior to the dinner there was a whist drive at which Mr. R. A. Miles and Mr. J. Masters officiated as M.C.s, and subsequent to the dinner Mr. F. A. Harper acted as M.C. for the dancing. The Toast Master was Mr. J. Hogg. There was an attendance of about 200 members and friends.

The Toast of the Institute and the Branch

The loyal toast of "The King—Duke of Lancaster" having been honoured, MR. F. O. L. CHORLTON, M.I.MechE. (President of the Manchester Association of Engineers) proposed the toast of "The Institute of British Foundrymen and the Lancashire Branch." In the course of a speech, delivered in jocular vein, he said that he had been endeavouring to collect his thoughts into a suitable mould, but actually he felt more like an ordinary riser after a very busy scene of plate moulding. There was a time, many years ago, when he served part of his apprenticeship in the foundry, and as a result thereof he had held a very high appreciation of the handicraft skill of moulders ever since. This appreciation had not been diminished by the occasions when he had seen the beautiful way in which defects had been filled up in castings which had been received at his own works!

Foundry work demanded very great hardihood as well as skill. In his younger days, when not quite as much attention was paid to the comfort of the moulder as was at the present time, it used to be a very cold job indeed in winter. The winter he spent in the foundry was, unfortunately for him, the very bitter one of 1894/5. For about three months the thermometer used to go down to zero every night, and, what was worse, he was engaged on loam moulding, which, as they all knew, was a very wet job. The men used to find the moulds frozen every morning, and it was quite breakfast time before they could really make a start with the work. As a matter of fact, the men used to have the appearance of the Children of Israel in the fiery furnace, being absolutely surrounded by buckets of burning coke while trying to get the moulds thawed out. (Laughter.)

It used to be said that a foundry was as cold as a prison. There was a good deal of truth in the statement, but even prisons as well as foundries had been very much improved in regard to the comfort of their occupiers.

The foundry was nowadays being assailed in many directions by alternative methods to producing castings. However, notwithstanding all the difficulties foundrymen had to face, he thought that, with some of the "grit" which they assimilated in their daily task, they would be able to attend the annual dinners for a great many years to come, and drink to the further success of "The Institute of British Foundrymen and the Lancashire Branch."

Increasing Recognition

MR. C. W. BIGG (President of the Institute), in responding to the toast, said that as a fairly old member of the Institute he had been able to appreciate the pride of the members in the work accomplished by their organisation. Also, during his year of office as President, he had noticed the increased interest in the Institute shown by important persons outside their own membership. It was becoming generally recognised that the Institute was an important factor in regard to the further progress which the industry hoped to make in future. To have inspired such recognition was something of which the Institute might well be proud.

The Lancashire Branch held the honour of being the first Branch formed in the Institute. It must be extremely interesting for the older members to regard the present advanced state of the industry as compared with its position in very early days. Remarkable developments had taken place, the scope and diversity of the products were on a much wider basis, and the term "foundryman" had a much more comprehensive application nowadays. The policy of the Institute was framed in order to cater for the needs of everyone concerned, from the managing director to the men on the floor, and in order to make for continuous progress that policy must be made as flexible as possible. Even the most conservative foundryman to-day—and he believed there were some conservative foundrymen even in Lancashire—was a far more progressive unit of the industry than was his fellow workman of a generation ago. If in connection with the policy of the Institute some brave individual had the courage to bring forward a suggestion which appeared to run contrary to present-day ideas, let them not condemn his proposal out of hand. Let them give it careful consideration, and offer constructive criticism in order that a perfectly just conclusion might be arrived at concerning its merits.

As President he wished to place on record his appreciation of the very able work done by the Lancashire Branch. Its contributions to the transactions of the Institute were such as to evoke the highest praise, and furthermore, it would be difficult to speak too highly in commendation of the efforts put forward by the hon. secretary, Mr. J. E. Cooke, on behalf of the Branch Council and the members generally.

In conclusion, he wished to state that the Institute looked with confidence for an even greater measure of support from the Lancashire Branch in the future than it had been their privilege to receive in the past.

Visitors and Guests

The toast of "Our Visitors and Guests" was proposed by MR. R. A. JONES (Branch-President), who said that the Lancashire Branch had certainly made progress both in respect to status and to numbers and with regard to the amount of subscriptions received. A very great deal of the credit for this was due to the secretary, Mr. J. E. Cooke.

MR. F. D. WEBB (Secretary of the Manchester and District Ironfounders' Employers' Association), in responding to the toast, explained that his job as a secretary was to keep the "bosses" working amicably so that they would be able to make sufficient money to pay the staff their wages. Having informed his hearers as to what were his own particular duties, he turned his attention to some of the guests. First, there was Mr. Bigg, a managing director of Qualcast, Limited, and President of the Institute. Managing directors also had duties to fulfil—he had found that out. Their duties were to think and to organise. The art of being a good organiser was to get somebody else to do all your work for you. He was deeply conscious of having to reply for such distinguished guests as the Mayor of Swinton and Pendlebury, Alderman Mycock, and the Mayoress, Mrs. Mycock; Mr. F. O. L. Chorlton, the President of the Manchester Association of Engineers; Mr. J. L. Herbert, chairman of the Manchester Metallurgical Society; Mr. R. W. Stubbs, the chairman of the Manchester and District Ironfounders' Association, and Past-President of the Institute, and Mr. T. Makemson, the Secretary of the Institute.

Letters of apology had been received from Mr. V. C. Faulkner, a Past-President of the Institute and Editor of THE FOUNDRY TRADE JOURNAL, Mr. N. P. Newman (Newman, Hender & Company, Woodchester, Gloucestershire), Mr. Joseph Hepworth (Senior Vice-President of the Institute), and Mr. J. W. Thomas (chairman of the N.W. Section of the Institute of Electrical Engineers).

The Honorary Secretary

The toast of "The Honorary Secretary of the Lancashire Branch, Mr. J. E. Cooke," coupled with the name of Mrs. Cooke, was proposed by the Branch-President, MR. R. A. JONES, and honoured by all present.

Presentation of Diplomas

The President of the Institute, Mr. C. W. Bigg, then presented the Diploma of the Institute to Mr. R. Ballantine (Mossend) and Mr. E. W. Wynn (Cannock) in acknowledgment of the Papers contributed by those gentlemen to the Proceedings of the Institute.

The recipients suitably acknowledged the presentation.

American Notes

One of the most significant trends in motor-car manufacture for 1938 is the increasing use of die-castings. Zinc die-cast grilles first made their appearance in the 1936 models, being cast in one piece. The cost was prohibitive, and in the following year a number of companies reverted to stamped grilles. The present year has witnessed a distinct return to favour for die-cast grilles, cast in three parts—the left side, right side and centre. Thus, if any of the parts are damaged they may be replaced without the necessity of purchasing an entire new grille.

* * *

A number of instrument panels are now die-cast instead of being stamped. One manufacturer has die-cast rims for headlamps, and another has contracted for die-cast side-hood louvres.

Canadian Iron and Steel Output

Production of pig-iron in Canada during 1937 was 32 per cent. higher than in 1936, and the output of steel ingots and castings was up by 26 per cent. The tonnage of pig-iron at 897,855 long tons was the greatest since 1929, when 1,080,160 tons were made, and the output of steel at 1,401,011 tons was higher than in any year since 1918, when the tonnage was 1,672,954. The output of ferro-alloys totalled 75,288 tons, against 76,284 tons and 56,616 tons in 1936 and 1935, respectively.

The Works of John Harper (Meehanite), Limited

When the directorate of John Harper & Company, Limited, of Albion Works, Willenhall, decided to acquire a licence for the manufacture of Meehanite castings, they deemed it expedient not only to form a subsidiary company, but also to build a new foundry. The complete building is arranged with north-light roofing, having ample glazing to ensure good light for the workpeople. The moulding, sand-preparing and core shops all have a height from the floor to the underside of the roof trusses of 22 ft., with a mean shop height of 28 ft.

The design of the new moulding shop closely follows that which has proved so successful in the firm's previous experience. There are two main bays, each 45 ft. wide, one of which carries a three-ton Morris overhead electric travelling crane, and down the centre of the shop, which is 270 ft. long, are runways for handling the liquid metal, whilst along the walls are the various moulding machines. For handling the finished castings resort is made to petrol-driven trucks. The melting shop is housed in an annex situated at the end of the shop.

A corridor, which is paved, as are all the main foundry gangways, with square cast-iron plates, having a studded surface, is reserved for handling the ladles from the cupola to the shop, and passengers to and from the melting shop pass by the cupola control department. At this end, too, the sand preparation is located.

For the artificial illumination of the foundry, mercury discharge lamps, specially designed for use with black sand, are used, giving a general lighting of 10 ft. candles. For other departments, ordinary metal filament lamps have been chosen, giving a general intensity of 8 ft. candles. The new works are heated by a modern low-pressure steam system.

An important feature, often inadequately considered, is that of flooring for foundry buildings. In this case, the core-making, sand milling and sand blast departments have been laid with grano-finished concrete floors, whilst for the dressing and despatch departments heavy creosoted timber blocks have been used.

The first cast was made on June 9 of last year, and nothing beyond a few teething troubles have been experienced during the application of the new process. It is generally accepted in the industry that the skin of the castings made in the Albion Foundry is excellent, and it is pleasing to note that this is being maintained in the new department. Only in certain highly-alloyed heat, wear and acid-resisting material, where practice resembles that of steel casting, can any slight departure from standard be noticed.

Melting Plant

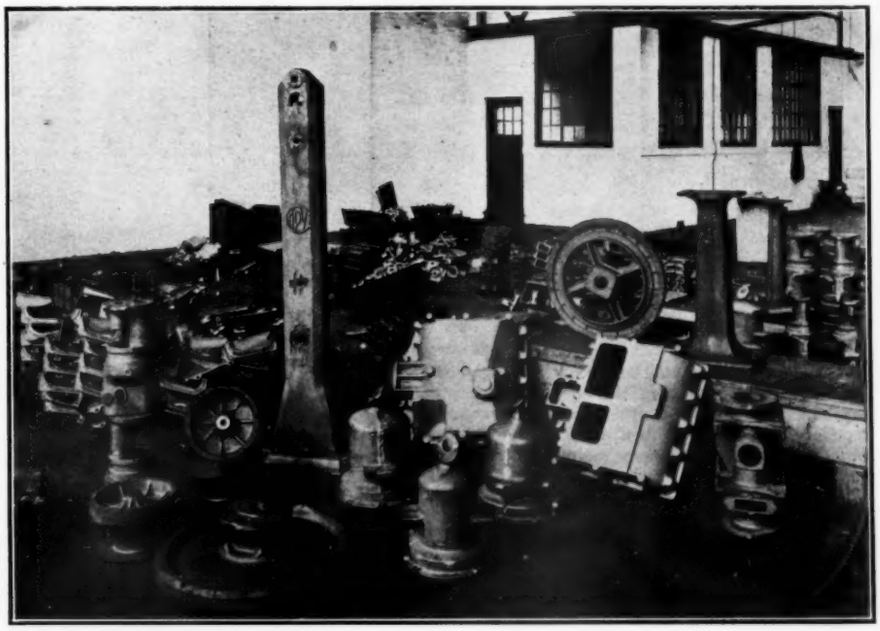
When the Meehanite system was adopted, it was deemed desirable to adopt the type of cupola designed by Mr. Oliver Smalley, the directing head of the Meehanite activities. This step has been amply justified, as the cupola is not only more economical in operation but also yields hotter metal. It has been constructed by Pneulec, Limited, is brick-lined and blown by a Keith Blackman fan. It is 17 ft. 6 in. from the bed to the charging door. The shell diameter is 58 in., which is lined down to 38 in., and this is easily capable of yielding 4 tons per hour. The blast pipe, which is 15 in. in diameter, carries the air from the fan located immediately below the charging floor. The tuyeres, which are six in number, are aligned as a single row, and are splayed from an outside dimension of 9 in. by 4½ in. to an inside measurement of 8 in. by 4 in. A feature of this cupola is the installation of a small blower, mounted on the top of the wind belt, for providing air for the lighting up of the drying fire. The handling arrangements for the raw materials are of a standard character, utilising the usual hoist and wheelbarrow. The cupola is housed in a 40 by 40 ft. building—the stage being totally enclosed—and should it ever be found necessary to double the capacity of the moulding shop, this building will be centrally disposed, instead of as now at the end of the shop. The charging platform is totally enclosed. It is interesting to note that the whole operation of the cupola is constantly under the control of a skilled metallurgist, provided with a working bench, instruments and signalling apparatus.

Sand Preparing

This department occupies an area of 45 ft. by 30 ft., and the Pneulec company have also been responsible for the provision of the necessary plant, which is of simple character. The used sand is first put through a distintegrator, the exit of which feeds a short length of belt running over a magnetic pulley for removing tramp iron and the like. This belt feeds into the bucket-loading device of a 6-ft. mill, the rollers of which do not rest upon the bottom plate, but are adjustable in this respect. Ploughs keep the sand constantly turning over. New sand and coal-dust additions are made at the bucket elevator, whilst moisture content is controlled in the mill itself. As this system created a certain amount of dust, and moreover as nowadays girl coremakers (who work nearby in the main building) spend quite a lot of money on hairdressing and cosmetics, it was deemed necessary to overcome this, so the mill has been provided with a lid. This feature is worth emulation, as an ounce of coal dust in the sand is worth two in the atmosphere.

Just inside the foundry is a really nice oil-fired layout for drying and heating up the shanks. These are lighter in section than most encountered in foundries, but, because of the care bestowed upon their preparation, are essentially safe. Just nearby is a satisfactory home-made system of core-sand drying, which utilises the flowing power of dry sand, so that no fuel is wasted in heating up sand beyond its flowing potentiality, which corresponds with dryness. The core-making department, which occupies an area of 45 ft. by 90 ft., has no special characteristics as the management is naturally adverse to making a major installation until such time as they have data as to the general trend of the business of making Meehanite castings. The oil sand is prepared in a Rotoil mixer and Pneulec were responsible for supplying the core- and mould-drying stoves, for both green-sand and dry-sand practices are followed. The stoves, of which there are three, are oil-fired. The whole of the flues are controlled from the front of the ovens, and air circulation is effected by

ANNEX FOR MELTING PLANT, JOHN HARPER (MEEHANITE), LIMITED.



A GROUP OF TYPICAL CASTINGS MADE IN MEEHANITE AT THE NEW FOUNDRY.

bringing the hot gases in at the top and allowing them to leave by flues built into the floor. They are controlled at 230 deg. C.

Moulding

Moulding is effected from both loose patterns and by four Zimmermann jar ram turnover machines and eight more of the firm's own design. Both Sterling steel boxes and their own type of iron moulding boxes are used, the latter carrying a slip on the bottom for retaining the sand. Box storage is provided in a separate building, common to the old and new foundries. At the moment facing sand is taken to the moulders by barrows, whilst the moulds are carried by hand from the machines, each machine feeding its own section. Casting is carried out during the afternoon only.

GENERAL VIEW OF THE NEW FOUNDRY OF JOHN HARPER (MEEHANITE), LIMITED, WILLENHALL.

Fettling and Despatch

This department is housed in a shop 150 ft. long by 67 ft. 6 in. wide, which appears to the writer to be of almost too generous a scale in relation to the foundry as it at present exists. Yet for a decade or more the size of the fettling and other auxiliary departments has been constantly growing, in order to comply with the ever increasing severity of buying specifications.

Up to now, there has been installed a Guttmann rotary table shot-blast machine and a room. There is a bank of double-ended grinders, but at the moment the lay-out is of a provisional character, and the only fixed feature is the sunken loading bay for facilitating the despatch of the castings. As we esteem the fettling department of the main works to rank amongst the best lay-outs in Europe, it is reasonably certain that when this shop assumes its final aspect it will also be of outstanding merit.

Meehanite Metal

Meehanite metal is embraced within a series of high-duty cast irons. The range is divided into five categories, and amongst it are included irons with properties which are controlled to meet specific service requirements, such as combined strength and toughness; corrosion and acid resistance; abrasion and erosion; pressure tightness; high resistance to shock and strain, and intense hardness by chilling or heat-treatment. The whole of the properties are set out in tabular form in the publicity matter issued in connection with Meehanite, so that users have reliable data upon which they can base their designs.

The new foundry is, for the time being, resorting to the parent company for all such services as mechanical testing and canteen and welfare, each one of which has been highly developed. In conclusion, the writer wishes to acknowledge, with sincere thanks, the courtesies he invariably receives from the directorate of this company, and especially to Mr. Wilfred Harper and Mr. H. Field for the help they have given in the preparation of this article.

Publication Received

Elektron. Published by the Producers, Suppliers and Manufacturers of Elektron Magnesium Alloys, and obtainable from F. A. Hughes & Company, Limited, Abbey House, Baker Street, London, N.W.1. Price 10s. 6d.

This excellently produced brochure is intended more for the use of engineers and designers than foundry executives, and no details are given as to manufacture. As many foundries are attached to engineering works, there is in the book a distinct appeal for them, because their business goes much farther than the production of castings, as it is the finished machine which is the final endeavour. This book discloses methodically all the properties of Elektron metal, together with much advice as to how to handle it in the machine shops so as to eliminate fire risks and effect rapid and satisfactory machinery. Extracts from all the various Air Ministry specifications are included, whilst much information as to surface treatment is given. The section covering the applications of Elektron is most illuminating, and indicates where major developments have taken place and points the way to future uses. The tabular matter, which is extensive, has been well chosen, and the only criticism we have to make is that the index is insufficiently complete. As a specialised text book for the modern engineer it is excellent value for money.

Feeders and Runners for Malleable-Iron Castings

In the course of a discussion on the gating and feeding of castings, held by the East Midlands Branch of the Institute of British Foundrymen recently, MR. H. J. BECK spoke on the subject with reference to malleable-iron castings. Extracts from his remarks are given below.

The composition sought from black-heart malleable cast iron is as follows:—Total carbon, 2.3; silicon, 0.7 to 1.0; manganese, 0.25 to 0.35; sulphur, 0.03 to 0.08, and phosphorus, 0.20 per cent. maximum. The charge is melted to give a spout temperature of 1,500 deg. C. in air furnaces of from 5 to 22 tons capacity. The charges are roughly 47 per cent. of special English pig-iron; 50 per cent. domestic hard scrap, and 3 per cent. annealed scrap and steel. It will be realised that, with this analysis, the shrinkage obtained is very high, and consequently contraction difficulties are increased. Contraction is of the order of 0.23 in. per ft.

Generally speaking, moulds must be poured quickly, as it is necessary to fill them with liquid metal so that there is the time and temperature for the thicker sections of the casting to secure the advantage of the necessary feeders and chills.

It is not always desirable to pour heavy castings of varying sections through a feeder on a thick section, as this is a frequent source of trouble. It may give a grey or mottled fracture and may introduce pulls, small fissures or cracks set up by local heating of the mould. It is, therefore, very desirable in cases of large or heavy castings not to introduce too much metal in one place, but rather to distribute the metal evenly to get a more uniform rate of cooling and solidification.

The weight percentage of feeders and runners is one of the major problems besetting the malleable-iron foundry industry. If the malleable-iron foundryman can get the average weight of his feeders and runners down to 45 or 46 per cent. of his good castings for his year's output of 20,000 tons of sound motor-vehicle castings, he has done something worth while. Many examples are available which are sound with about 30 per cent. of feeder and runner, yet there are others, which are plainer and easier to mould, where the feeder amounts to 130 per cent.

About 95 per cent. of the castings by weight are poured through strainer cores, and only the lightest are poured without. Something of the order of 75 per cent. are poured through two strainer cores varying in type and shape.

When a new job has to be made the foundry manager, patternshop foreman, foundry foreman and works manager decide the best way to make the pattern, where to core out, whereabouts the joint line is to be, the best way to mould, the best way to cast up for feeding purposes (which is not always the easiest for moulding), and how many patterns to put in a box with a view to running and feeding; this is essential before the patterns are put on the plate, as the plate otherwise would often be scrapped if the patterns required moving afterwards.

Design in Relationship to Contraction and Distortion

In connection with the Paper on this subject in our February 3 issue, the author, Mr. E. Longden, wishes to make the following amendments and correct some minor errors. On page 116, column 2, lines 19 and 20, the text should read, "If the bars are separated from the grid or frame as at E, Fig. 5. . . ." On the same page, column 3, line 2 should read, "1 in.; 2 in., and 4 in.," and not "3 in." On page 117, column 3, 4th line from the bottom, "the bedplate had completed nearly 75 per cent. of its total contraction," and not 756 as printed.

The Metallurgy of Cast Iron

By A. E. PEACE and P. A. RUSSELL, B.Sc.

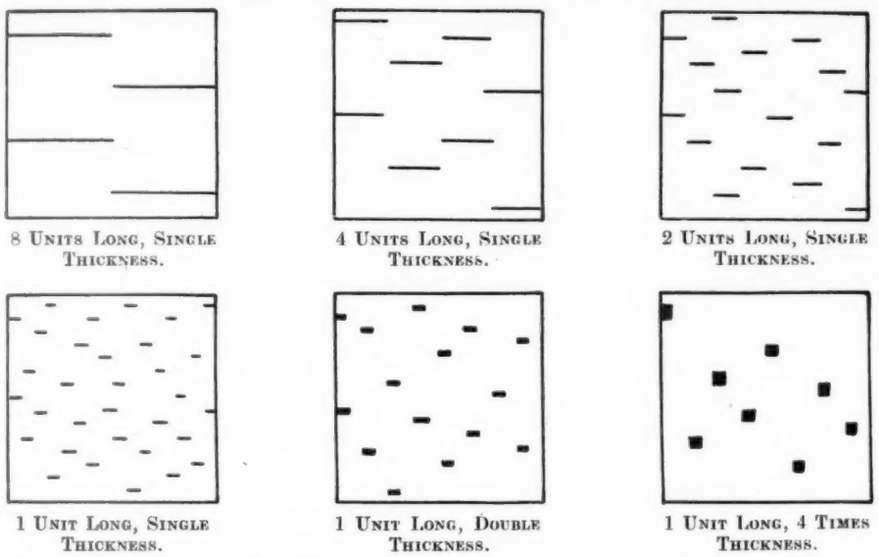
(*Concluded from page* 137.)

PART II

By P. A. RUSSELL.

It is now proposed to discuss the factors given by one of the authors (Mr. Peace) and show how these factors govern the other properties of cast iron, particularly (*a*) strength, (*b*) pressure tightness and general soundness and (*c*) heat resistance.

From the point of view of tensile strength, grey cast iron can be regarded as one of the many qualities of steel, weakened by the presence of graphite flakes. As previously shown, the matrix may be ferrite, pearlite or cementite, or a combination of two of these three, except that cementite is usually absent from grey cast iron. The tensile strength of ferrite with silicon in solid solution may be taken as 28 tons per sq. in., and coarse pearlite as 40 tons per sq. in. This latter may be improved up to 80 tons per sq. in. by heat-treatment.



8 UNITS LONG, SINGLE THICKNESS. 4 UNITS LONG, SINGLE THICKNESS. 2 UNITS LONG, SINGLE THICKNESS.

1 UNIT LONG, SINGLE THICKNESS. 1 UNIT LONG, DOUBLE THICKNESS. 1 UNIT LONG, 4 TIMES THICKNESS.

FIG. 17.—DIAGRAMMATIC REPRESENTATION OF POSSIBLE ARRANGEMENTS OF SAME AMOUNT OF GRAPHITE.

Influence of Graphite

From this it will be seen that the weakening effect of graphite is of very great importance. Of the total carbon present a maximum of 1 per cent. can exist in true grey iron as part of the matrix, so that the balance is all graphite. Graphite has a low specific gravity, so that 2½ per cent. of graphitic carbon by weight will occupy 7½ per cent. of the total volume. In addition, it is held by many authorities that voids occur alongside the graphite which increase the volume. But, far more important than the actual volume occupied by graphite, it is the flake shape which reduces the strength of the matrix, and it is the size and distribution of the graphite that is the main controlling influence in the strength of grey cast iron. As a broad principle, the strength of cast iron is progressively increased from the weakest state, much coarse graphite in a matrix of ferrite, by a reduction in graphite size and quantity, and an increase in the amount of pearlite.

Great stress is often laid on the importance of a pearlitic matrix for strength, but its importance is much less due to the strength of pearlite as compared with ferrite, than to the fact that increased combined carbon involves decreased graphite. Thus all the factors which conduce to reduced graphite are the factors that conduce to increased strength. The fact remains, however, that two irons having the same analysis, including the quantity of graphite, can have widely different strengths, and this seems to be almost entirely due to the graphite size and distribution. Fig. 17 is a mathematical expression of this. Each view has the same length of line differently divided. The attention of metallurgists throughout the world is now concentrated on this problem, and it is not yet possible to account for all the factors which influence graphite size and distribution. The importance of fracture as an adjunct to analysis is now recognised. It should be sufficient for the purpose of this Paper to indicate the present methods by which graphite size can be made less than would be expected from analysis and general conditions. They are as follow:—

(1) The use of cold blast in the blast furnace.

(2) By taking up the temperature of the metal in the melting process considerably above normal. The metal may be allowed to cool down to normal before pouring.

(3) By adding the graphite-producing elements after the iron is melted, *i.e.*, by producing an iron that would normally run white, but to which graphitising materials, such as ferro-silicon, calcium silicide or nickel, are added after melting. This process is called inoculation.

(4) By vibrating the melted metal.

(5) By passing gas of a mildly oxidising nature, such as carbon dioxide, through the liquid metal, provided that sufficient titanium in the right condition is present.

All these processes are not equally effective, but from them it will be seen how many different methods there are and consequently how many factors are involved.

Influence of Phosphorus

The influence of phosphorus has to be considered. As previously explained, the phosphorus eutectic is present in increasing quantities as phosphorus increases. This is weak and brittle, but if it is present in an iron that is weak, owing to the presence of coarse graphite, then its effect on tensile strength is negligible and it only affects the brittleness. As the strength of iron is improved by reduction of graphite quantity and size, so the effect of phosphorus becomes greater. This is illustrated in Fig. 18. When the phosphorus eutectic is in network form, the iron is stronger than when it is in massive form.

Sulphur and Manganese

Sulphur and manganese have little effect on the strength, provided that sulphur is balanced by adequate manganese. High manganese will give a little added strength. To summarise this Table I is given showing analyses that may be expected to give the tensile strengths stated in test-bars cast 1.2 in. dia. and machined to 0.798 in. For lesser thickness, carbon, silicon and phosphorus may be increased, and for greater thicknesses they must be decreased.

It must not be forgotten that decreasing silicon and phosphorus is normally accompanied by increasing carbon, the eutectic or natural amount of carbon being shown in Table I. To obtain the higher strengths, this tendency must be counteracted in the metal mixture by the use of steel scrap or refined iron. Alternatively, nickel and nickel-chromium combinations may be used, which permit of higher carbon and less risk of chilling in thin sections, at the same time strengthening the matrix. No analyses are given for irons of over 17 tons per sq. in., as these are usually specially low in carbon and/or are produced by one of the graphite-refining processes already referred to.

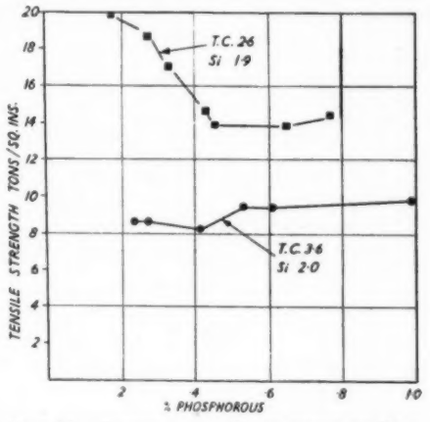


FIG. 18.—INFLUENCE OF PHOSPHORUS ON TENSILE STRENGTH OF TWO TYPES OF CAST IRON. M TEST-BARS. (FROM REPORT OF CAST IRON SUB-COMMITTEE TO I.B.F., 1934.)

TABLE I.—*Suggested Analyses to Give Various Strengths in M Bars.*

Tensile strength Tons per sq. in.	Total carbon. Per cent.	Graphitic carbon. Per cent.	Silicon. Per cent.	Phosphorus. Per cent.	Eutectic or natural total carbon. Per cent.
9	3.5	3.3	2.5	1.5	3.1
11	3.5	3.1	2.2	1.1	3.3
14	3.4	2.7	2.0	0.8	3.5
17	3.3	2.5	1.5	0.2	3.8
alternatively 17	3.6	2.6	1.5 Nickel 1.5	0.2 Chromium 0.5	3.8

Tensile strength is not the only factor of importance from the strength point of view, but resistance to shock is equally important. The study of this side of cast iron is still in its infancy, largely owing to the lack of a suitable test. The repeated impact test is difficult to interpret, and is in the nature of a shock test for brittle irons, and a fatigue test for tough

irons. A single impact test modified from the standard Izod test is now being developed by the B.C.I.R.A., and appears to have considerable possibilities. The study of transverse-test deflections when separated into elastic and plastic deflection also throws some light on the toughness of cast iron. It is, therefore, only possible to generalise, but it can be said that phosphorus, as already mentioned, increases the brittleness, and irons in which high tensile strength have been obtained by carbon reduction alone are sometimes liable to be brittle, but if the strength is obtained by one of the graphite refining processes, then, broadly speaking, the toughness is improved.

In considering strength, malleable cast iron can only be touched on very briefly. There are two forms, whiteheart and blackheart. Both are produced from castings made originally in white iron in which there is little or no primary graphite. The castings are then annealed, the whiteheart in an oxidising atmosphere, and the blackheart in a neutral atmosphere. The oxidising atmosphere removes the bulk of the carbon so that a casting approximating to steel is obtained with a tensile strength of 28 tons per sq. in. (approximately), whereas in the blackheart process the cementite is decomposed forming iron and temper carbon. The carbon being in nodular form has little effect on the strength, and again a casting approximating to steel is obtained with a tensile strength of 24 tons per sq. in. (approximately). In this respect it is interesting to note that blackheart contains 2¼ per cent. of graphitic carbon, which, being in nodular form, has little effect on the strength, but the same amount of carbon in primary or flake form would make the iron into an ordinary grey iron with tensile strength of only about 12 tons per sq. in.

Structural Uniformity and Pressure Tightness

Under this heading the problems are twofold: firstly the tendency of grey cast iron to have coarser graphite in thick sections than thin sections, and, secondly, the risk of definite cavities owing to shrinkage problems.

The problem of graphite size is really one of minimising the effect of cooling rate on the structure, particularly the graphite size, of cast iron. In many ways the problems are the same as those associated with strength, in that a fine graphite iron, particularly those produced by the special processes enumerated, is less liable to variation in structure in various thicknesses than a coarse graphite iron.

The production of fine graphite for this purpose is better accomplished by the use of low silicon and phosphorus than by very low carbon, as the shrinkage of the latter is high, and if definite cavities are not formed there is a risk of microscopic cavities forming alongside the graphite flakes with consequent lack of pressure tightness. Unfortunately, in castings of varying section, which have to be machinable, silicon cannot be reduced below a certain limit, dependent upon the thickness of the thinnest section. It is in this respect that nickel is of particular value, for if 0.5 per cent. of silicon is replaced by 1.5 per cent. of nickel, irons can be run in much thinner sections without chilling, and thick sections do not have their graphite size increased to the same extent. In addition, various external aids, such as the use of denseners, can be used to equalise the cooling rate, but this does not come within the scope of this Paper.

The second problem, that of the risk of the presence of definite cavities, is more difficult, particularly as the factors which tend to improve structural uniformity often increase the risk of cavities. The amount of decrease in volume in cast iron in changing from liquid to solid is governed mostly by the graphite. The formation of graphite is accompanied by an expansion, so that the greater the amount of graphite, the less the volume decrease; in fact, irons with large quantities of graphite have no volume decrease.

It would appear at first sight that a very coarse graphite iron would be desirable to avoid the presence of internal cavities, but graphite in excess of the eutectic amount is extremely coarse and porous, and the casting might leak under pressure via these coarse flakes. Therefore, from the point of view of the avoidance of internal cavities an iron with carbon just below the eutectic amount according to the silicon and phosphorus (such as the 14-ton tensile iron in Table I) is usually used where the avoidance of cavities is the prime factor.

Frequently, however, such an iron is of too coarse a graphite structure, and the use of an iron with still lower carbon is necessary. Then it becomes necessary to study the running and feeding of the job to ensure that fresh liquid metal is fed in to replace the deficiency caused

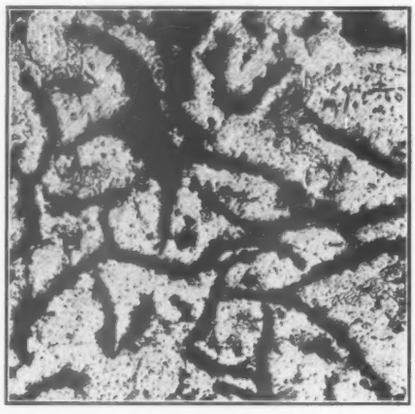


FIG. 19.—BURNT GREY CAST IRON. GRAPHITE AND IRON OXIDE IN FERRITE. × 200.

by the solidification shrinkage of the metal. Fortunately, this type of iron usually shows its deficiency in external sinks instead of internal cavities, so that the necessary feeding is easier to carry out.

Heat Resistance

Cast iron fails under heat in four ways: (1) growth; (2) scaling; (3) fracture, and (4) softening. It is proposed, briefly, to examine these causes of failure.

Growth is caused by internal oxidation of the metal. The oxygen attacks the graphite, forming carbon monoxide or dioxide, and then the matrix forms iron oxide with resultant internal expansion (as shown in Fig. 19). Some growth also is caused by graphitisation of carbides, and the expansions and contractions caused by the change of pearlite into austenite and *vice versa*.

Scaling is allied to growth and is due to the oxidation of the surface layer of the metal, such layer being of greater volume than the unattacked metal behind it, with the result that the oxidised portion falls or cracks off as a scale.

Fracture occurs when the temperature of the casting suddenly changes, particularly where the change is localised, with the result that such severe internal strains are set up that the casting breaks.

Softening is largely a function of temperature and loading. Phosphoric irons collapse at the temperature of melting of the phosphorus eutectic, 950 deg. C. (approximately), and non-phosphoric irons at 1,150 deg. C. (approximately). Thus irons for resisting heat are of varied types to withstand the particular conditions involved.

The various heat-resisting cast irons will now be briefly surveyed from the point of view of these four causes of failure.

Hematite Cast Iron with low silicon with or without the addition of up to 1 per cent. of chromium is satisfactory for resistance to fracture and softening. It has moderate growth- and scale-resisting properties, particularly if chromium is present to retard the breakdown of the carbides.

"*Silal*," with low carbon and 5 per cent. of silicon, has good growth- and scale-resisting properties owing to the fine graphite and the protection against oxidation of the ferrite accorded by the high silicon. It also resists softening, but, being brittle, is liable to fracture.

Austenitic Cast Irons ("Nicrosilal" and "Ni-Resist").—In these there is sufficient nickel or nickel and copper to retain the iron in the austenitic condition at normal temperatures, so that there is no transformation on heating. The austenitic matrix is also fairly resistant to oxidation, particularly in "Nicrosilal," due to high silicon, and the carbon is low and finely divided and the iron is tough and strong. These are, therefore, the best heat-resisting cast irons yet developed from all points of view; the principal difficulties in connection with their use are associated with their low thermal conductivity and high coefficient of expansion, which tend to distortion if they are unequally heated.

The majority of the illustrations used are taken from the series of "Typical Microstructures of Cast Iron including Malleable Cast Iron," published by the Institute of British Foundrymen, for which due acknowledgment is made.

DISCUSSION

MR. W. T. EVANS (Branch-President) said it was very gratifying that they had members of the Institute who could give them the calibre of lecture that had been given that night. He asked one of the lecturers for a further description of "eutectic."

After MR. P. A. RUSSELL, in reply, had given the standard salt and water analogy MR. H. BUNTING suggested it would have been better if the lecturer had expressed the view that the eutectic alloy was the alloy with the lowest freezing point.

MR. S. E. DAWSON then re-stated the analogy.

An Experience of Graphite Separation

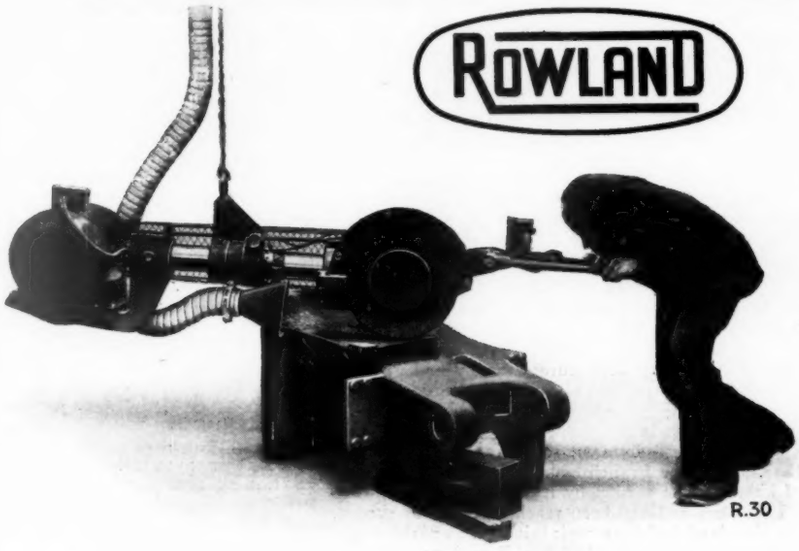
MR. B. HIRD, in dealing with the question from the foundry standpoint, said he had had an experience of the eutectic point and the separation of graphite which still puzzled him. He had melted a pig-iron, the analysis of which, as far as he could remember, was T.C, 3.9; Si, 2.0; Mn, 0.5; and P, 0.6 per cent. It was bought to analysis, and when melted there were signs of graphite being thrown out as metal came down the cupola spout. By the time casting was started, the graphite came out in flakes, and the castings were very bad. As the carbon was 3.9 per cent., and the eutectic was 4.3 per cent., how was it that graphite was thrown out of solution?

MR. A. E. PEACE pointed out that the eutectic was lowered by 0.3 per cent. carbon for each 1 per cent. of silicon and phosphorus, so that the eutectic of the iron cited by Mr. Hird was reduced to 3.5 per cent., and as the iron actually contained 3.9 per cent. carbon, the excess was thrown out on cooling as kish. Molten iron would dissolve much more carbon than the eutectic quantity, but on cooling the excess carbide separated out and very easily graphitised.

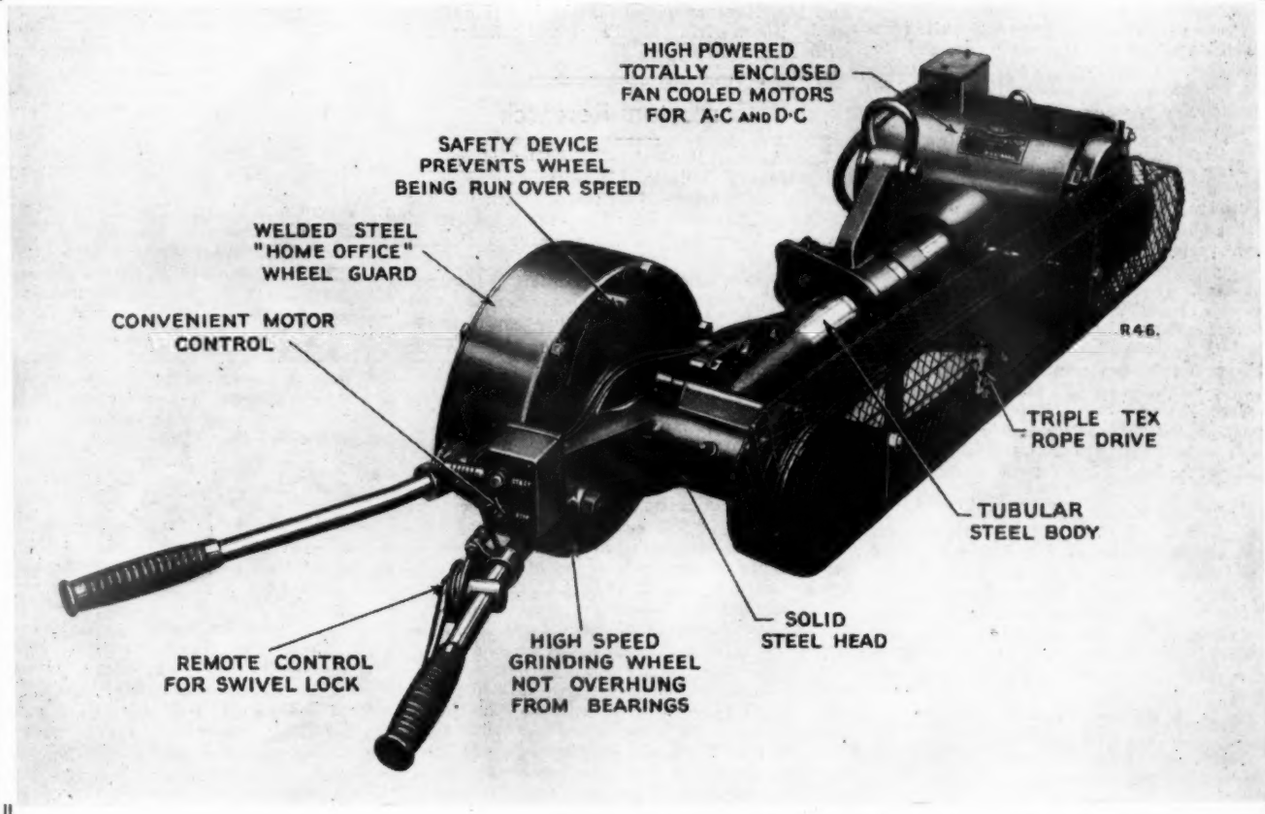
MR. DAWSON, referring to the remarks of Mr. Peace regarding manganese and its hardening effect on the carbides, said that, in the first place, by neutralising the sulphur it would have the effect of softening the iron. He believed Mr. Peace had said nickel above 4 per cent. brought about hardening. If that were so, why was austenite so soft when it contained high nickel? Had he any suggestion why austenite was non-magnetic?

MR. PEACE said Mr. Dawson was quite correct in his remarks regarding manganese. There should be 1¾ times the sulphur content to ensure all the sulphur being combined as manganese sulphide. If there were less than that amount of manganese present, a hardening would result, due to the sulphur. Manganese in a high-sulphur iron acted as a softener. To retain a fully austenitic structure, considerably more than

ROWLAND



HIGH SPEED PORTABLE GRINDER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HIGH SPEED GRINDING WHEEL NOT OVERHUNG FROM BEARINGS
REMOTE CONTROL FOR SWIVEL LOCK

THIS machine can show a greater saving than any other piece of equipment in the Foundry. It is light to handle and the wheel can be used in almost any position. Its all steel construction makes it immensely strong, and other important features are referred to in the illustration. Most important of all the bearings for the grinding wheel are inside the collet so that the wheel does not overhang the bearings.

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5 per cent. nickel was necessary. Austenite was non-magnetic because it was a modified form of iron, entirely different from ordinary iron at room temperature. If one did not get a fully austenitic structure, the material was slightly magnetic.

Maximum Hardness

MR. F. G. BUTTERS referred to two photomicrographs shown by Mr. Peace, one of 2.6 per cent. T.C, which showed a small amount of cementite, and one of 3.3 per cent. T.C. He asked for the maximum Brinell hardness obtainable in straight irons, and inquired whether the increased carbon was accompanied by increased hardness and brittleness.

MR. PEACE asked the meeting to bear in mind that the iron Mr. Butters had mentioned was white cast iron. The increase in the amount of carbon increased the amount of cementite and made the iron harder and more brittle. The maximum hardness obtainable without alloying was about 450 Brinell. The hardness was a good guide in the case of rolls or any chilled casting, because usually they were made to a hardness specification. The chilled-roll makers worked with a carbon high enough to secure the desired hardness and low enough to retain sufficient strength in the necks.

MR. J. C. HALLAMORE asked if the ferritic, pearlitic, martensitic and cementitic irons were white or machinable.

MR. PEACE replied that in grey and white irons the pearlite was the major constituent, and was machinable. Ferrite was even more easily machinable, whilst the martensitic structures were practically unmachinable.

Copper Additions

MR. T. GOODWIN observed that one had to be very careful when criticising experts, but the crux of the whole subject really was the carbon, in one shape or another, and that could be altered by so many various constituents, which could make iron either soft or hard. The ordinary foundryman did not know where he stood, and had a great variety of different mixtures thrust upon him at the present day. The speaker had known it to be stated that, by a simple addition of copper, foundrymen would get neither hard spots nor open grain in the casting, and he hoped the lecturers could prove that. Referring to tensile strengths, he asked Mr. Russell what he anticipated the tensile strength of an iron with 2.65 per cent. carbon and 1.5 per cent. silicon would be.

MR. PEACE said the members would all realise that they had talked chiefly about carbon; and, after all, the material they called cast iron was really an alloy of carbon in iron. It was the forms of the carbon which affected all the qualities of the iron. It would, of course, be appreciated that the subject was very complicated, and the authors had tried to make the members a little more familiar with some aspects of the subject.

In reply to the question regarding copper, and how simple additions prevented hard spots, and at the same time prevented open grain, Mr. Peace said that copper undoubtedly did this, under certain circumstances and conditions. In the case of nickel, this closed the grain, in spite of the fact that it favoured graphite formation. Elements could work in two ways, and it was very difficult to discuss one element alone.

MR. RUSSELL, referring to Mr. Goodwin's query on tensile strength, said that, firstly, the size of the casting had to be considered, and, secondly, there was the question of phosphorus. The iron of the analysis cited would be white in a small bar.

MR. GOODWIN said the tensile bar was made as the ordinary round tensile bar. The fracture was grey, and the tensile strength was over 29 tons.

Graphite Distribution in Thick Sections

MR. SANDERS said Mr. Russell had stated that the quantity of graphite in a fairly thick section was practically uniform throughout. That was a factor which was not always understood, because on fracturing a thick casting there was apparently more graphite in the centre than at the edges.

MR. HIRD, referring to a hematite iron, said that with a phosphorus content under 0.2 per cent. he got a rougher skin than with a phosphoric iron, the metal apparently eating into the sand. Did the phosphorus, by some action on the carbon, prevent that eating in? The iron was a soft grey hematite.

MR. RUSSELL thought the reason was obscure, and suggested that the low-phosphorus iron had a higher freezing point and had to be poured hotter than the phosphoric iron. He would not say that was the only explanation.

Vote of Thanks

MR. R. SPRIGGS, proposing a vote of thanks, said it was not the first time he had been impressed by the combination of Mr. Peace and Mr. P. A. Russell as lecturers. They had given a very fine lecture, and although the subject was a purely technical one, they had made it extremely interesting.

MR. R. H. BUCKLAND, seconding the vote of thanks, said the Branch had been given a number of lectures that session by its own members, and a high standard had been reached. He was sure the standard had been maintained that night.

MR. PEACE, on behalf of Mr. Russell and himself, thanked the members for their attention, and MR. RUSSELL added that he had thoroughly enjoyed both giving the Paper and collaborating with Mr. Peace.

Corrosion Research

The Annual Report* of the Department of Scientific and Industrial Research for 1936-37, just issued, reviews the recent work of the Chemistry Research Board on the corrosion of metals. A summary of the relevant sections is given below.

In regard to atmospheric corrosion, it is stated that the influence of air movement on the rate of corrosion of iron has been investigated in relation to the composition of the air. In stagnant conditions the repressive effect of carbon dioxide has been demonstrated both for unsaturated atmospheres and atmospheres intermittently reaching saturation, and both in the absence and presence of traces of sulphur dioxide. In contrast, the rate of corrosion of zinc in humid atmospheres containing traces of sulphur dioxide is increased by additions of carbon dioxide. The "dry oxidation" of zinc has been studied intensively with particular reference to the influence of temperature and of surface condition.

To study immersed corrosion, experiments with rotating specimens of mild steel have been continued in N/2 sodium-chloride solution, Teddington tap-water, and natural sea-water. Conclusions which bear on the formulation of standard corrosion tests have been published. Under stagnant conditions in the above-mentioned solutions the distribution of corrosion on completely-immersed specimens has been found to depend more on differences of surface preparation than on any differences of aeration between parts of the specimens.

The iodine method of isolating thin oxide films from iron and steel has been investigated. The results show that the presence of oxygen is necessary for complete separation, and suggest that some reinforcement of the films by precipitated material occurs during the isolation process. Technical problems in course of investigation have included the corrosion of magnesium alloys by leaded petrol fuel, the rapid pitting of a water-supply system, and the corrosion of locomotive-boiler tubes.

It may be noted that a report describing in detail the work of the Chemistry Research Board for the three years to December 31, 1937, will be published shortly.

* Cmd. 5647. H.M. Stationery Office, Adastral House, Kingsway, London, W.C.2. (Price 3s. net.)

Notes from the Branches

Falkirk Section.—The advantages offered by the British Foundry School in developing the ironfounding industry in Great Britain were explained to the members of Falkirk section of the Institute of British Foundrymen by Mr. J. Bamford, B.Sc., when he addressed a meeting in the Temperance Café, Falkirk, on February 5. Mr. H. Cowan, B.Sc., chairman of the section, was in the chair.

MR. BAMFORD referred first of all to the slow progress made by the ironfounding industry through the centuries, and showed how Continental countries were first to take action in improving matters by establishing schools for the training of young ironfounders. Only in recent years had Britain grasped the importance of such a step, and thus there was formed the British Foundry School. It catered, said the speaker, for the young men who were already established in the industry, and who had attained a certain standard in technical education. These men obtained their practical and preliminary technical training first (generally simultaneously by means of evening classes) and then attended the British Foundry School for a year's course to extend their theoretical knowledge. As these men were usually sent by their employers, the question of their subsequent absorption by the industry after the course did not exist.

Organised and specialised foundry education was an essential for this country, said Mr. Bamford, if the British foundries were to compete with foreign foundries in the future. The British Foundry School originated in proposals put before the Board of Education in 1933, and was received with great interest by representatives of institutions who undertook to support the school financially. The Board of Education had also undertaken to help financially, and its grants formed the major part of the income of the school. For various reasons, Birmingham was chosen as the centre, and accommodation was obtained in the buildings of the Birmingham Central Technical College.

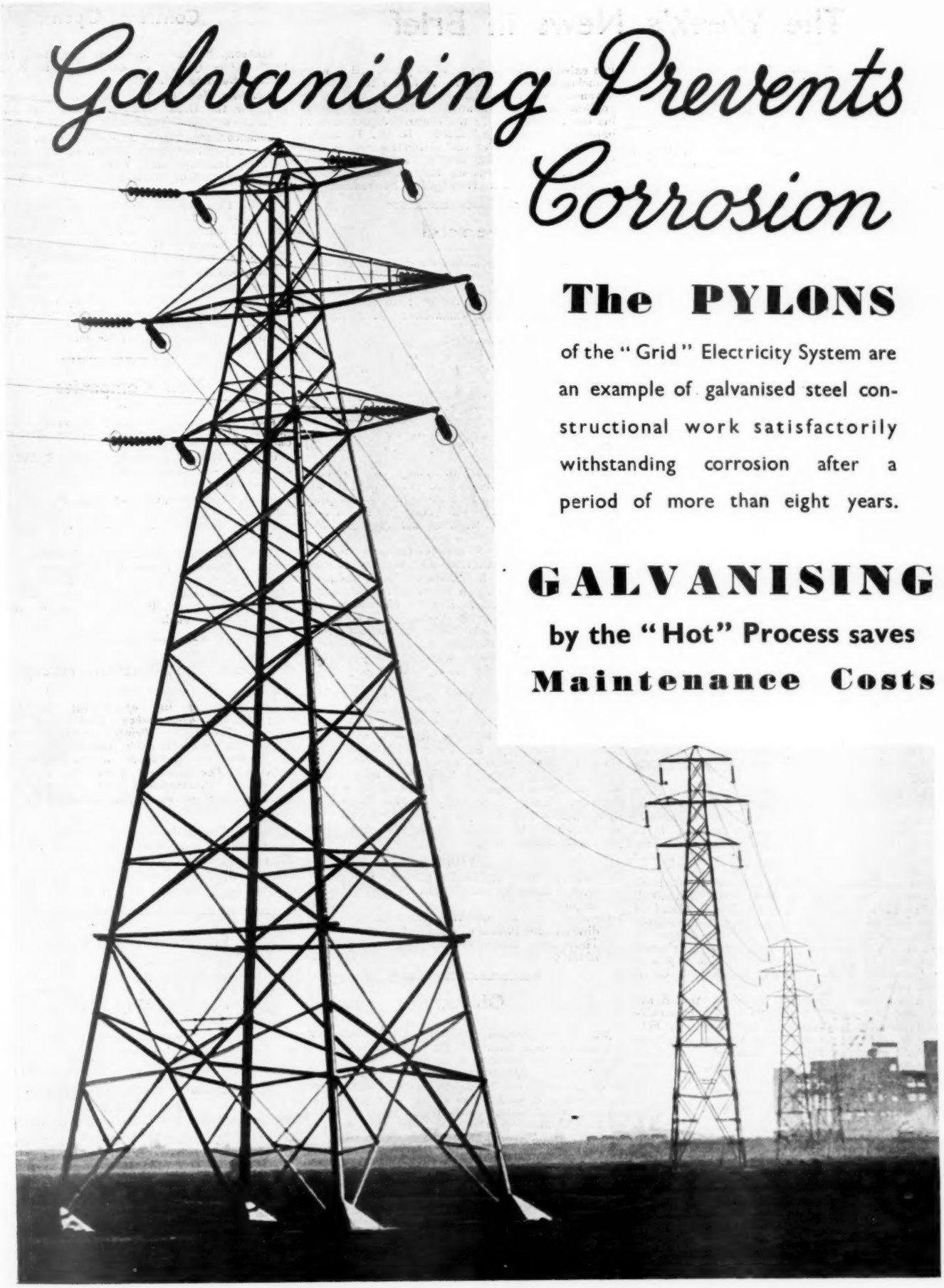
The school did not teach the practice of founding. It was assumed that the only way to become proficient in the art was to get experience in the shops themselves, and that any knowledge gained by practice in educational institutions could be more quickly and satisfactorily acquired in the foundry itself. Therefore, one of the conditions of admittance was a certain amount of previous practical training.

Mr. Bamford went on to deal with the curriculum, which, he said, covered the whole field of foundry work, and explained that during the course weekly visits were paid to local foundries, while there was one annual visit, lasting for a week, to another foundry centre. Successful students in the final examination received the diploma of the British Foundry School.

Mr. Bamford said that there was no age limit for the school. The usual procedure was for the firm to pay the school fees of £30, together with any expenses incurred, and to continue to pay the student his usual salary. The approximate minimum maintenance of a student for the course was £120. Any individual, however, who desired to take the course, and had no private means of meeting the costs, could obtain assistance from his local Education Authority. Students from South Africa, New Zealand and Egypt had attended the school. It was felt that the main function of the school was to benefit the industry, and to serve it in as many ways as possible. Its future development, however, depended upon the support it obtained from the industry.

TWENTY LOCOMOTIVES of a new class are now being constructed by the Great Western Railway at its Swindon works. They are of the 4-6-0 general utility type and will be used on express passenger and freight train services.

Galvanising Prevents Corrosion



The PYLONS

of the "Grid" Electricity System are an example of galvanised steel constructional work satisfactorily withstanding corrosion after a period of more than eight years.

GALVANISING

by the "Hot" Process saves

Maintenance Costs

The Week's News in Brief

Trade Talk

THE ANNUAL CONFERENCE of the French Foundrymen's Technical Association is to be held at Lyons from June 9 to 11 next.

THE INTERNATIONAL NICKEL COMPANY OF CANADA, LIMITED, has declared a quarterly dividend of 50 cents on the common stock.

PLANS FOR extensions and alterations to the works of Baker Perkins, Limited, Peterborough, have been approved by the Peterborough City Council.

THE TRANSFERENCE of the galvanising plant at the Bowesfield Steel Works, Stockton, to Dorman, Long & Company's Middlesbrough works has now been completed.

VICKERS ARMSTRONGS, LIMITED, laid the keel recently, at the Walker-on-Tyne Naval Yard, of the cruiser "Nigeria," which is the first of five 8,000-ton cruisers ordered about Christmas.

THE HEAD OFFICE and showrooms of the Cambridge Instrument Company, Limited, will be removed next Monday from 45, Grosvenor Place, to 13, Grosvenor Place, London, S.W.1.

CLOCKS AND WATCHES presented by the management of Ley's Malleable Castings Company, Limited, Derby, to employees with 21 years' service with the firm, now total 511.

THE NEW CANTEEN and sports pavilion of Aveling-Barford, Limited, Grantham, replacing the building destroyed by fire last year, have been opened by Lord Brownlow, Lord Lieutenant of Lincolnshire.

THE MOTHERWELL BRIDGE & ENGINEERING COMPANY, LIMITED, has received a new contract to build three oil tanks at Bowling, Dumbartonshire. The firm is busy at present with a large order for tanks for Iran.

THE BURNLEY DIECASTING COMPANY, LIMITED, is being wound up voluntarily. Mr. J. P. Wood, 7, Grimshaw Street, Burnley, and Mr. H. V. Wood, District Bank Chambers, Huddersfield, are joint liquidators.

AN ORDER for a large motor-driven oil-tanker has been received by Barclay, Curle & Company, Limited, Glasgow, from foreign owners. The propelling machinery, which will consist of Barclay-Curle-Doxford opposed-piston oil engines, will be built at their North British Engine Works.

CONTRACTS VALUED at £1,200,000 were secured by Clyde shipbuilding firms in the first month of the year, the orders including two oil tankers, two escort vessels for the Admiralty, two motor launches for the Clyde "taxi" services, two lifeboats for the R.N.L.I., and a twin-screw motor vessel for the L.M.S.

THE EIGHTH annual conference of the German Vitreous Enamellers' Association will be held during the Leipzig Spring Fair at the Hotel Sachsenhof from March 4 to 6. The technical session is to be held in the afternoon of Saturday, March 5, in the Green Room of the hotel, and visitors are invited to participate.

WILLIAM DOXFORD & SONS, LIMITED, Sunderland, have received an order from the Court Line, Limited, London, for a motorship, to be fitted with a Doxford opposed-piston oil engine, and Joseph L. Thompson & Sons, Limited, Sunderland, are to construct a steamer, the triple-expansion engines of which will be supplied by the North-Eastern Marine Engineering Company, Limited. Both vessels will be of 10,000 tons deadweight.

MOLER PRODUCTS, LIMITED, inform us that it has been mutually agreed between the two companies that General Refractories, Limited, shall, on February 5, cease to act as agents for the insulating materials of Moler Products, Limited. As from February 7 Moler Products, Limited, will deal direct with all their sales, and all inquiries for "Fosalsil" and "Insulite" products should be sent direct to them at 103, Kingsway, London, W.C.2.

SIR CHARLES GRANT ROBERTSON (Vice-Chancellor and Principal of Birmingham University) last week presented at a conversazione held in connection with the University Metallurgical Society, the Thomas Turner gold medal to Dr. H. W. Brownsdon, for original research work. Thomas Turner bronze medals were awarded to Messrs. W. T. Pell-Walpole, F. A. Ball and S. G. Temple. The Vice-Chancellor explained that the Thomas Turner Trust was founded in order to commemorate the services of Prof. Turner to metallurgy in its various aspects. Dr. Brownsdon's original investigations in metallurgy had extended over a period of 30 years, and in many branches of the science they had been the means of advancing the knowledge of metallurgy and of the application of that knowledge. For a large part of his life he had been in the research departments of important metallurgical firms. In Dr. Brownsdon they had a scientist of real distinction, whose work was a credit to British science. Prof. Hanson presided, and an address on the progress of metallurgical research was given by Dr. Brownsdon.

Personal

MR. LÉON GUILLET has had the degree of Doctor of Applied Science conferred upon him by the University of Prague.

MR. H. J. WARD has retired from the board of J. & E. Hall, Limited, engineers and ironfounders, of Dartford.

MR. M. HENDERSON CLARK, of Middlesbrough, has been re-elected President of the North-East Coast Association of Iron, Steel and Metal Merchants.

MR. L. B. DERRY, who has been foundry manager with Petters, Limited, of Yeovil, since 1924, has resigned. Previous to joining that firm he was foundry manager with Peter Brotherhood, Limited, Peterborough, and Crossley Bros., Limited, Manchester.

MR. ROBERT HUTTON, for many years foreman moulder with the Shotts Iron Company, and who recently transferred to R. Y. Pickering & Company, Limited, Wishaw, was the guest of his former colleagues, last week, when he was presented with a gold wristlet watch.

MR. P. BARRY PARKS, who for the past five years has been works metallurgist and foundry manager of the Hong Kong & Whampoa Dock Company, Limited, of Hong Kong, is returning to this country on long leave. Whilst in England his address will be care of Matheson & Company, Limited, 3, Lombard Street, London, E.C.3, the London agents of his company. Previous to joining the Hong Kong concern, Mr. Parks was for four years with the Riverside Ironworks, Limited, of Calgary, Alta., Canada.

MR. D. A. OLIVER, M.Sc. (Eng.), F.Inst.P., has been appointed head of the research and technical investigation section of the combined laboratories of William Jessop & Sons, Limited, and J. J. Saville & Company, Limited, of Sheffield. Mr. Oliver had many years of varied research experience at the National Physical Laboratory, and later at the research laboratories of the General Electric Company, Limited, Wembley, before transferring to Sheffield nearly four years ago. He has made a special study of magnet steels and the newer permanent magnet alloys.

Wills

SOWDEN, J. W., of David Sowden & Sons, Limited, ironfounders, etc., Shipley £15,473

THOMPSON, A. E., of Wolverhampton, director and former chairman of John Thompson Engineering Company, Limited £313,221

Obituary

MR. H. W. TAYLOR, chief of the turbo-generator engineering department of the B.T.-H. Works at Rugby, died on February 1, aged 58.

DR. KAREL LOEVENSTEIN, chairman of the board of directors of the Skoda works, died in Prague on February 3, at the age of 52. He joined the military administration of the Skoda works at Pilsen at the outbreak of the war. In 1919 he was appointed secretary-general of the company, and soon afterwards a member of the board and assistant managing director. Four years later Dr. Loevenstein became managing director, and in 1934 chairman of the board of directors.

Company Report

English Electric Company, Limited.—Dividend of 10 per cent. for the year 1937 on the ordinary stock.

Contracts Open

Stafford, February 22.—Iron and steel, for the Staffordshire County Council. Mr. R. S. Murt, County Buildings, Stafford.

Skegness, February 21.—Cast-iron pipes, castings, etc., for the Urban District Council. Mr. R. H. Jenkins, engineer, Town Hall, Skegness.

Johannesburg, March 28.—18 4-ton and 4 15-ton electrically-driven portal jib cranes, for the South African Railways and Harbours Administration. The Department of Overseas Trade. (Reference T.Y. 17,431/38.)

Largs, February 22.—Provision and laying of spun-iron pipes in 21-in., 16-in., 12-in. and 9-in. sizes, the total length being 4,762 yds., for the Town Council. Carter & Wilson, C.E., 51, Queen Street, Edinburgh, 2. (Fee £2 2s., returnable.)

Johannesburg, March 3.—Machinery, including one Diesel engine, two alternators, three switchgear panels, three transformers, one A.C. motor, also cable, cable-end boxes, etc., for the Union Tender and Supplies Board. The Department of Overseas Trade. (Reference T.Y. 17,428/38.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

W. & C. Hewlett, Limited.—Capital, £1,000. Metal founders, etc. Director: W. Hewlett, 37, Hillside Avenue, Whitefield.

R. Lloyd & Company, Limited, 11, Elm Street Lane, Cardiff.—Capital, £1,500. Iron and brass founders. Directors: R. A. Lloyd and Mrs. A. B. Lloyd.

V. B. Reichwald (Successors), Limited, Norfolk House, 7, Laurence Pountney Hill, London, E.C.4.—Capital, £1,000. Iron and steel merchants, ironfounders, mechanical engineers, etc. Directors: E. E. Reichwald, F. B. Ridgwell, B. W. Lazenby and J. M. Reichwald.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

476,800. WILLIS, G. W. Process for the manufacture of iron, steel, and ferrous alloys from pig-iron.

476,866. BOLTON & SONS, LIMITED, T., and CHILD, G. W. Centrifugal casting.

Forthcoming Events

FEBRUARY 21.

Sheffield Society of Engineers and Metallurgists.—"Some Engineering and Metallurgical Problems of the Mining Industry." Paper by Prof. I. C. F. Statham, at Mappin Hall, St. George's Square, Sheffield, at 7.30 p.m.

FEBRUARY 25.

Manchester Association of Engineers:—"Planned Publicity for Engineering Products." Paper by F. Rowlinson, at Engineers' Club, Manchester, at 7.15 p.m.

Institute of British Foundrymen

FEBRUARY 26.

East Midlands Branch:—Annual dinner, at Derby.

Newcastle Branch:—"Toughness of Cast Iron from Transverse Stress/Strain Curves," Paper by G. L. Harbach, at Neville Hall, Westgate Road, Newcastle-upon-Tyne, at 6.15 p.m.

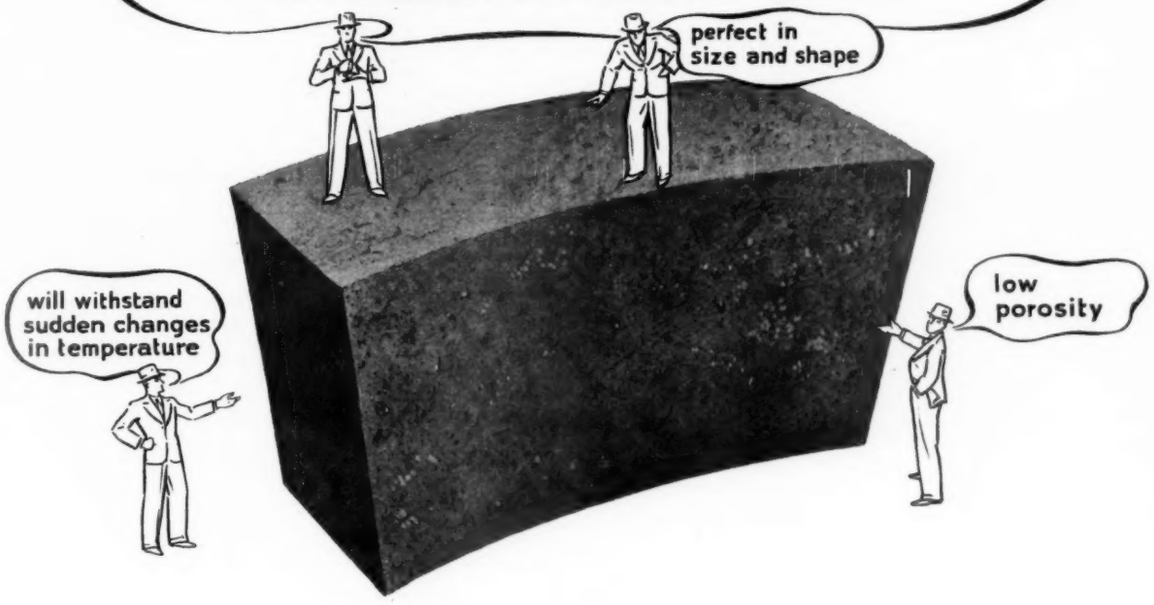
Wales and Monmouth Branch:—"More Non-Ferrous Problems," Paper by F. Dunleavy, at Y.M.C.A., Llanelly, at 6.30 p.m.

The Institute of Vitreous Enamellers

FEBRUARY 24.

Scottish Section:—"Colour and Its Effects on the Appearance of Enamelled Ware," Paper by J. Jackson, at Royal Technical College Society's Rooms, Glasgow, at 7.30 p.m.

Reliability - is certainly the word to describe these bricks



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SCOTTISH OFFICE: 48, West Regent Street, Glasgow, C.2. Telephone: Douglas 6108 (3 lines). Telegrams: "Genefax, Glasgow." (Mr. C. A. G. Thomson).

SWANSEA OFFICE: Metropole Chambers, Wind Street. Telephone: 3680. Telegrams: "Genefax, Swansea." (Mr. D. F. Hood-Williams).

MANCHESTER OFFICE: 9, Albert Square. Telephone: Blackfriars 6130 Telegrams: "Genefax, Manchester." (Mr. S. G. Throssell).

MIDDLESBROUGH OFFICE: Halifax Bldgs., Exchange Place, Telephone: Middlesbrough 3313. Telegrams: "Genefax, Middlesbrough." (Mr. J. A. Williams).

CARDIFF OFFICE: 17, Windsor Place, Telephone: 5796. Telegrams: "Genefax, Cardiff." (Mr. F. E. Rutter).

Raw Material Markets

This period of the year is customarily a rather quiet time for the heavy industries, and new business is not on a large scale. There continues to be talk of an impending slump, or trade recession, as it is more often described nowadays. Undoubtedly, it is much too early in the year to be able to declare that trade is on the decline; activity may yet reach the high level of last year. Pig-iron makers are able to accumulate a little stock, but steelmakers are fully occupied in meeting their contract commitments, which fell so heavily into arrear last year.

The output of iron and steel in January was maintained at a very high level notwithstanding the New Year holidays and other factors tending to restrict production. The January figures are given at the foot of this page

Pig-Iron

MIDDLESBROUGH.—Consumers of pig-iron being well contracted, there is little in the nature of new business at the present time, and pressure for deliveries in most cases is not heavy. Some consumers are taking the opportunity to build up stocks while they have the chance, as it is expected that supplies will be less easily obtained later in the year. Export inquiries are very infrequent. For delivery in the Middlesbrough or Falkirk areas, No. 3 Cleveland G.M.B. is quoted at 109s., less 5s. rebate, 111s. on the North-East Coast, and 112s. on Clydeside, with No. 1 foundry at 2s. 6d. per ton above the foregoing prices.

Although contract commitments are substantial, there is little new business offered in hematite. Some users are taking up small tonnages to supplement deliveries. The demand from overseas is still on the quiet side. Including delivery on the North-East Coast, East Coast mixed numbers are quoted at 132s. 6d., less 5s. rebate.

LANCASHIRE.—Makers of textile machinery and light castings continue to find trade rather dull, but in other consuming establishments work is proceeding at a good rate, and users are taking up fairly good deliveries. It is noticeable, however, that there is little pressure, and new orders are conspicuous by their absence. For delivery in the Manchester price zone, Derbyshire and Staffordshire No. 3 is quoted at 114s. per ton, with Northamptonshire at 112s. 6d. and Derbyshire forge iron at from 111s. to 113s., according to the class of consumer. Scottish No. 3 is at 141s. Subject to 5s. rebate, West Coast hematite is quoted at 141s., with East Coast iron at 140s. 6d., delivered in Manchester and district.

MIDLANDS.—Apart from the light-castings works, which have been quiet for a considerable time, there is now a tendency towards slacker conditions at other consuming plants, including the motor and electrical trades. Stocks are accumulating both at the producing establishments and the consumers' depôts. On the other hand, there are good reports from the heavy engineering concerns, while the machine-tool makers are also working satisfactorily. Low-phosphorus iron, at from £6 5s. to £7 7s. 6d., is being used in heavy tonnages. With the exception of the special qualities, supplies of hematite are plentiful. Most consumers have booked deliveries over several months. Prices have been fixed up to the end of the year.

SCOTLAND.—The light-castings foundries are now finding themselves in the unusual position of being pressed to take up supplies for which they had previously contracted, instead of having difficulty in procuring tonnages, as was the case throughout the whole of last year. At the present time, new inquiries are very scarce. This applies to all branches. No. 1 foundry iron is quoted at 120s. 6d., with No. 3 at 118s., f.o.t. furnaces. Local steelworks are active and are pressing for deliveries. Hematite mixed numbers are quoted at 133s., with Scottish basic at 107s. 6d., and English and Indian basic at 100s., less 5s. rebate.

Coke

For delivery to Birmingham and district, best Durham foundry coke is quoted at 55s. 9d., with Welsh coke at from 55s. to 62s. 6d., according to quality. Consumers are taking up quite good deliveries under contracts, but new inquiries are not plentiful. Some producers continue to find difficulty in complying with their commitments.

Steel

Quiet conditions continue to rule in the steel market, but, although new business is scarce, heavy tonnages are passing into consumption, says the official report of the London Iron and Steel Exchange. Most of the large consumers have covered their requirements for some time to come, and this, with the arrival of imports arranged for when there was a scarcity of practically all kinds of steel, has created a lull in active trading. These imports, however, should soon be absorbed, and a resumption of busy conditions is then expected. In the semi-finished steel departments, supplies are now adequate to meet the needs of all the consuming branches of the trade. There are now no complaints of works operations being hindered by the lack of this class of material. Although the production of finished steel is maintained at a high level, it is difficult to place orders for certain descriptions except for forward delivery. Export business remains quiet, but recently there has been rather more inquiry from several overseas markets.

Scrap

Some recession is noticeable in the demand for iron and steel scrap, and there is a tendency in some districts for prices to sag. Especially is there a lesser demand from the ironworks, but activity at the steelworks is maintained. Prices of steelworks' scrap are fixed by agreement, but values of scrap which are not subject to control are generally easier.

Metals

Advices from Wall Street have been slightly more cheerful this week, although the improvement has scarcely been sufficient to make any material change in business in this country. There can be no doubt that it is the unsatisfactory American position that is depressing trade here.

Copper.—Little change has occurred in this market during the past week and business has continued to be dull. Japanese inquiries have declined of late. As we have stated before, while there is no improvement in the American position, the market in this country has little chance of making any headway. When buying is resumed, however, it is likely to be on a substantial scale.

The world stocks of refined copper increased during January by 34,770 tons to 505,960 tons. The apparent consumption was 139,520 tons. The output by mines and smelters totalled 168,560 tons. The production of refined copper totalled 174,300 tons. The publication of these figures strengthened the market.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £38 8s. 9d. to £38 11s. 3d.; Friday, £38 3s. 9d. to £38 5s.; Monday, £38 5s. to £38 7s. 6d.; Tuesday, £38 8s. 9d. to £38 11s. 3d.; Wednesday, £39 3s. 9d. to £39 5s.

Three Months.—Thursday, £38 13s. 9d. to £38 16s. 3d.; Friday, £38 8s. 9d. to £38 10s.; Monday, £38 10s. to £38 12s. 6d.; Tuesday, £38 13s. 9d. to £38 15s.; Wednesday, £39 8s. 9d. to £39 10s.

Tin.—A meeting of the International Tin Committee will take place on Friday. It is generally agreed that a further cut in the quota for the ensuing quarter will have to be made. With regard to conditions in the United States, C. S. Trench & Company, New York, state that "the market continues to make a good showing considering the lack of demand, but there has been no forced selling in any quarter and those who are 'carrying the bag' appear to be strong enough to go on with it. There seems to be no prospect of any material improvement in American consumption before the spring, and, despite curtailment in manufacturing operations, it is believed that no inroads will be made into consumers' stocks of tin and tin products this quarter."

Capt. Oliver Lyttleton, chairman of the London Tin Corporation, interviewed in Kuala Lumpur, denied reports emanating from London that he was an envoy of the buffer pool proposers. He also denied that he was trying to undermine Malayan opposition to a buffer pool scheme, and said categorically that the London Tin Corporation would not participate in a private pool in any circumstances.

The Amsterdam "Telegraaf" learns from Mr. J. van den Broek, managing director of the Billiton Maatschappij, that nothing whatever is known there of negotiations for the shipment of United States tin to Holland. Reports from America were to the effect that the American Tin Syndicate had opened negotiations for weekly shipments of 10,000 tons of ore to Arnhem, the large Dutch tin works of the Billiton Maatschappij. According to the report, the ore would be shipped from Michigan, where ore deposits of at least 5,000,000 tons were said to have been discovered. Mr. van den Broek says such a discovery is practically out of the question. According to a report from America, Mr. McReynolds, chairman of the House of Representatives Foreign Affairs Committee, has announced that an immediate investigation of reports of extensive tin ore deposits in the upper Michigan peninsula would be made.

Official quotations were as follow :—

Cash.—Thursday, £180 5s. to £180 10s.; Friday, £179 5s. to £179 10s.; Monday, £180 5s. to £180 10s.; Tuesday, £181 5s. to £181 10s.; Wednesday, £184 5s. to £184 10s.

Three Months.—Thursday, £180 5s. to £180 10s.; Friday, £179 5s. to £179 10s.; Monday, £180 to £180 5s.; Tuesday, £181 5s. to £181 10s.; Wednesday, £184 to £184 5s.

Spelter.—Day-to-day buying has again formed the basis of trade in this metal, and, under existing conditions, little incentive is offered to consumers to enter into long-term contracts. It is noticeable in this market, also, that orders for Japan have become less regular. The current American price is 4.75 cents per lb., East St. Louis. The world's output of spelter in 1937 totalled 1,849,367 short tons, as compared with 1,650,222 tons in 1936, according to the American Bureau of Metal Statistics.

Daily market prices :—

Ordinary. — Thursday, £13 15s.; Friday, £13 16s. 3d.; Monday, £13 13s. 9d.; Tuesday, £13 12s. 6d.; Wednesday, £13 16s. 3d.

Lead.—Consumers are taking up moderate tonnages, but business continues to be adversely affected by political influences, especially in the United States, although the rather better news from Wall Street has been encouraging. Lead is being sold in the United States at 4.35 cents per lb. at St. Louis, and 4.50 cents at New York. The Metallgesellschaft estimates that the world's smelter production of lead amounted to 1,653,762 metric tons in 1937, against 1,455,233 tons in the previous year.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £14 18s. 9d.; Friday, £14 13s. 9d.; Monday, £14 15s.; Tuesday, £14 17s. 6d.; Wednesday, £15.

Scrap.—Business has continued quiet, and prices have further declined.

Approximate selling prices for old metal :—New aluminium cuttings, £81; rolled, £66; cast, £40; foil, £88 to £90. Copper, £36 to £39; braziery, £33 to £34. Brass (clean), £23 to £24; Zinc, £9. Lead, £14 10s. Gunmetal, £38 to £39.

Iron and Steel Production

The British Iron and Steel Federation reports that there were 130 furnaces in blast at the end of January, compared with 133 furnaces at the end of December, three furnaces having ceased operations during the month. The production of pig-iron in January amounted to 761,100 tons, compared with 783,800 tons in December and 650,700 tons in January, 1937; the month's production included 175,500 tons of hematite, 411,200 tons of basic, 138,800 tons of foundry and 16,600 tons of forge pig-iron. The production of steel ingots and castings in January amounted to 1,081,400 tons, compared with 1,103,800 tons in December and 998,900 tons in January, 1937. New Year holidays and an involuntary stoppage on the North-East Coast affected steel output in January which was the highest recorded for the first month of any year. The pig-iron output was affected by the temporary withdrawal of three blast furnaces.

A New Factory of any size on a Rental Basis

ASSISTANCE WITH CAPITAL

Contributions towards Rent, Rates & Income Tax

ABUNDANT LABOUR

These are among the advantages that await the industrialist who comes to the Special Areas. In the Special Areas—in Northumberland and Durham, Scotland, South Wales and West Cumberland—labour is plentiful, skilled and unskilled, male, female and juvenile. Transport communications are excellent, natural resources rich and varied. Conditions combine with Government assistance to give industry a start free from all encumbrances — *the best start it has ever been offered in any country's industrial history.*

IN YOUR OWN INTEREST, and that of the business you own or contemplate starting, you should know the full scope of these important schemes of assistance. Write for complete information to the Secretary, Commissioner for the Special Areas, Broadway Buildings, Broadway, London, S.W.1 (for England and Wales); or at 13 Carlton Terrace, Edinburgh, 7 (for Scotland).

WARNER Special PIG IRONS

- Warner C.B.R. and Low Carbon Cylinder (FOR CYLINDERS, ROLLS, ENGINEERING CASTINGS, ETC.)
- Low Carbon Malleable (FOR MALLEABLE CASTINGS OF ALL DESCRIPTIONS)

Supplied to any specification between limits of 2·00 and 3·50% Carbon and ·50% and 3·50% Silicon

ACTUAL ANALYSIS CERTIFICATES ARE AVAILABLE WITH EACH DELIVERY

Typical Cylinder Pig Iron Specification

TOTAL CARBON	2·70%
SILICON	1·80%
MANGANESE	·90%
SULPHUR	·06%
PHOSPHORUS	·40%

Typical Malleable Pig Iron Specification

TOTAL CARBON	2·60%
SILICON	·75%
MANGANESE	·50%
SULPHUR	·05%
PHOSPHORUS	·06%

WARNER & CO., LTD
CARGO FLEET · MIDDLESBROUGH

RAW MATERIALS—PRICE LIST

(Wednesday, February 16, 1938)

COPPER

	£	s.	d.
Standard cash	39	3	9
Three months	39	8	9
Electrolytic	43	10	0
Tough	42	0	0
Best selected	42	10	0
Sheets	73	15	0
India	55	7	6
Wire bars	43	15	0
Ingot bars	43	15	0
H.C. Wire rods	47	5	0
Off. av. cash, Jan.	41	8	6½
Do., 3 mths., Jan.	41	12	8½
Do., Sttlmnt., Jan.	41	8	8½
Do., Electro, Jan.	45	16	0½
Do., B.S., Jan.	45	12	6
Do., Wire bars, Jan.	46	4	4½
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8d.

BRASS

Solid drawn tubes	11½d.
Brazed tubes	13½d.
Rods, drawn	9d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	8½d.
Wire	8½d.
Rolled metal	8d.
Yellow metal rods	6½d.

TIN

	£	s.	d.
Standard cash	184	5	0
Three months	184	0	0
English	184	5	0
Bars	186	5	0
Straits	186	5	0
Eastern	184	17	6
Banca (nom.)			—
Off. av. cash, Jan.	183	15	7½
Do., 3 mths., Jan.	184	1	8
Do., Sttlmt., Jan.	183	15	8½

SPELTER

	£	s.	d.
Ordinary	13	16	3
Remelted	11	10	0
Hard	11	5	0
Electro, 99·9	17	15	0
English	14	15	0
India	13	5	0
Zinc dust	20	10	0
Zinc ashes	4	15	0
Off. aver., Jan.	15	1	8
Aver., spot, Jan.	14	19	10½

LEAD

	£	s.	d.
Soft foreign, ppt.	15	0	0
Empire (nom.)	15	15	0
English	17	0	0
Off. aver., Jan.	16	3	10 17/32
Aver., spot, Jan.	16	2	8½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£	s.	d.		£	s.	d.
Zinc sheets, English	28	5	0	to 28	15	0	
Do., V.M. ex-whse.	28	5	0	to 28	15	0	
Rods				20	0	0	

ANTIMONY

	£	s.	d.		£	s.	d.
English	81	0	0	to 82	0	0	
Chinese, ex-whse.				69	0	0	
Crude, c.i.f.				42	0	0	

QUICKSILVER

	£	s.	d.
Quicksilver	12	17	3

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon—			
25%	12	10	0
45/50%	12	0	0
75%	17	0	0
Ferro-vanadium—			
35/50%	14/- lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	4/9 lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	9d. lb.		
Ferro-phosphorus, 20/25%	£21 to £22		
Ferro-tungsten—			
80/85%	6/- lb. (nom.)		
Tungsten metal powder—			
98/99%	6/1½ lb. (nom.)		
Ferro-chrome—			
2/4% car.	34	15	0
4/6% car.	24	5	0
6/8% car.	24	0	0
8/10% car.	24	0	0
Ferro-chrome—			
Max. 2% car.	36	0	0
Max. 1% car.	38	5	0
Max. 0·5% car.	41	0	0
70% carbon-free	10d. lb.		
Nickel—99·5/100%	£180 to £185		
"F" nickel shot	£165	0	0
Ferro-cobalt, 98/99%	8/6 to 8/9 lb.		
Metallic chromium—			
96/98%	2/5 lb.		
Ferro-manganese—			
76/80% loose	£18 15 0	to 19	5 0
76/80% packed	£19 15 0	to 20	5 0
76/80% export	£22	0	0
Metallic manganese—			
94/96% carbon-free	1/3 lb.		

Per ton unless otherwise stated, basis 2-ton lots.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	3s. 10d.
Finished bars, 18% tungsten	5s. 0d.

Per lb. d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 7/32 in.	1/- lb.
Flats, ¼ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£	s.	d.		£	s.	d.
South Wales (West)—							
Heavy steel, best	3	8	9	to 3	11	3	
Mixed iron and steel	3	6	9	to 3	9	3	
Heavy cast iron	3	8	9	to 3	11	3	
Good machinery				3	15	0	
Cleveland—							
Heavy steel, best	3	7	0	to 3	9	6	
Steel turnings	2	13	0	to 2	15	6	
Heavy cast iron				4	2	6	
Heavy machinery	4	7	6	to 4	10	0	
Midlands—							
Short heavy steel	3	17	6	to 4	0	0	
Light cast-iron scrap				3	2	6	
Heavy wrought iron	4	0	0	to 4	5	0	
Steel turnings	2	6	3	to 2	8	9	
Scotland—							
Heavy steel, best	3	5	0	to 3	7	6	
Ordinary cast iron	4	5	0	to 4	6	6	
Cast-iron borings	2	0	6	to 2	3	0	
Wrot-iron piling	4	5	0	to 4	7	6	
Heavy machinery	4	10	0	to 4	12	6	

London—Merchants' buying prices, delivered yard.

	£	s.	d.
Copper (clean)	31	0	0
Brass	22	0	0
Lead (less usual draft)	13	0	0
Tea lead	9	10	0
Zinc	7	10	0
New aluminium cuttings	68	0	0
Braziery copper	28	0	0
Gunmetal	32	0	0
Hollow pewter	125	0	0
Shaped black pewter	87	0	0

PIG-IRON*

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	111/6
,, No. 3	109/-
,, No. 4	108/-
Forge No. 4	108/-
Hematite No. 1	133/-
Hematite M/Nos.	132/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	133/-
,, d/d Birm.	144/6
Malleable iron d/d Birm.	165/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	110/-
,, No. 3 fdry.	111/-
Northants forge	107/6
,, fdry. No. 3	108/6
,, fdry. No. 1	111/6
Derbyshire forge	110/-
,, fdry. No. 3	111/-
,, fdry. No. 1	114/-
Scotland—	
Foundry, No. 1, f.o.t.	120/6
,, No. 3, f.o.t.	118/-
Cleveland No. 3, Glasgow	112/-
,, ,, Falkirk	109/-
Scottish hem. M/Nos. d/d	133/-
Sheffield (d/d district)—	
Derby forge	107/6
,, fdry. No. 3	108/6
Lincs forge	107/6
,, fdry. No. 3	108/6
W.C. hematite	138/6
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	114/-
Staffs fdry. No. 3	114/-
Northants fdry. No. 3	112/6
Cleveland fdry. No. 3	114/-
Glengarnock, No. 3	141/-
Clyde, No. 3	141/-
Monkland, No. 3	141/-
Eglinton, No. 3	141/-
Gartsherrie, No. 3	141/-
Shotts, No. 3	141/-

(* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0·75 per cent., are subject to a rebate of 5s. per ton under certain conditions.)

FINISHED IRON AND STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel sections, plates and joists is obtainable in the home trade under certain conditions.]

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	13	5	0	to 13	15	0	
Nut and bolt iron	11	12	6	to 12	2	6	
Hoops				14	2	6	
Marked bars (Staffs) f.o.t.				15	15	0	
Gas strip				14	2	6	
Bolts and nuts, ¾ in. × 4 in.				17	10	0 and up	
Steel—							
Plates, ship, etc.	11	8	0	to 11	10	6	
Boiler plts.	11	18	0	to 12	0	6	
Chequer plts.				13	0	6	
Angles				11	0	6	
Tees				12	0	6	
Joists				11	0	6	
Rounds and squares, 3 in. to 5½ in.				12	0	6	
Rounds under 3 in. to ⅜ in. (untested)				11	9	0	
Flats—8 in. wide and over				11	5	6	
,, under 8 in. and over 5 in.				11	10	6	
Rails, heavy				10	2	6	
Fishplates				14	2	6	
Hoops (Staffs)				12	4	0	
Black sheets, 24g. (4-t. lots)				15	15	0	
Galv. cor. shts. (,,)				18	10	0	
Galv. flat shts. (,,)				19	0	0	
Galv. fencing wire, 8g. plain				20	5	0	
Billets, soft, 100-ton lots				7	17	6	
Sheet bars				7	15	0	
Tin bars				7	15	0	

PHOSPHOR BRONZE

	Per lb. basis
Strip	10¾d.
Sheet to 10 w.g.	11¼d.
Wire	12¼d.
Rods	13¼d.
Tubes	18¼d.
Castings	15d.

Delivery 3 cwt. free.
10% phos. cop. £33 above B.S.
15% phos. cop. £38 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	8d. to 1/2
Rolled—	
To 9 in. wide	1/2 to 1/8
To 12 in. wide	1/2½ to 1/8½
To 15 in. wide	1/2½ to 1/8½
To 18 in. wide	1/3 to 1/9
To 21 in. wide	1/3½ to 1/9½
To 25 in. wide	1/4 to 1/10
Ingots for spoons and forks	6d. to 1/4½
Ingots rolled to spoon size	11d. to 1/7½
Wire round—	
to 10g.	1/5½ to 2/0½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/4½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	20.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang. 80%, seaboard	102.50
O.-h. rails, h'y, at mill	42.50
Billets	37.00
Sheet bars	37.00
Wire rods	47.00
	Cents.
Iron bars, Chicago	2.40
Steel bars	2.45
Tank plates	2.25
Beams, etc.	2.25
Skelp, grooved steel	2.10
Steel hoops	2.40
Sheets, black, No. 24	3.15
Sheets, galv., No. 24	3.80
Wire nails	2.75
Plain wire	2.90
Barbed wire, galv.	3.40
Tinplates, 100-lb. box	$5.35

COKE (at ovens)

Welsh foundry	42/6
,, furnace	37/6
Durham foundry	39/6
,, furnace	32/6
Scottish foundry	42/6
,, furnace	40/-

TINPLATES

f.o.b. British Channel ports.

I.C. cokes	20×14 per box		22/6
,,	28×20 ,,		45/-
,,	20×10 ,,		34/6
,,	18¾×14 ,,		24 9
C.W.	20×14 ,,	18/-	to 18/9
,,	28×20 ,,	36/-	to 37/6
,,	20×10 ,,	29/6	to 30/-
,,	18¾×14 ,,	21/-	to 21/6

SWEDISH CHARCOAL IRON & STEEL

Pig-iron	£12	0	0	to £13	0	0	
Bars-hammered, basis	£20	0	0	to £22	0	0	
Bars and nail-rods, rolled, basis	£19	0	0	to £20	0	0	
Blooms	£18	0	0	to £19	0	0	
Keg steel	£30	0	0	to £35	0	0	
Faggot steel	£20	0	0	to £25	0	0	
Bars and rods dead soft st'l	£19	0	0	to £20	0	0	

All per English ton, f.o.b. Gothenburg
[Subject to an exchange basis of Kr 19.39 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

		£	s.	d.		
Feb.	10 ..	38	8	9	dec.	11/3
,,	11 ..	38	3	9	,,	5/-
,,	14 ..	38	5	0	inc.	1/3
,,	15 ..	38	8	9	,,	3/9
,,	16 ..	39	3	9	,,	15/-

Electrolytic Copper

		£	s.	d.		
Feb.	10 ..	42	10	0	dec.	15/-
,,	11 ..	42	0	0	,,	10/-
,,	14 ..	42	0	0	No change	
,,	15 ..	42	0	0	,,	,,
,,	16 ..	43	10	0	inc.	30/-

Standard Tin (cash)

		£	s.	d.		
Feb.	10 ..	180	5	0	dec.	30/-
,,	11 ..	179	5	0	,,	20/-
,,	14 ..	180	5	0	inc.	20/-
,,	15 ..	181	5	0	,,	20/-
,,	16 ..	184	5	0	,,	60/-

Tin (English ingots)

		£	s.	d.		
Feb.	10 ..	180	5	0	dec.	30/-
,,	11 ..	179	5	0	,,	20/-
,,	14 ..	180	5	0	inc.	20/-
,,	15 ..	181	5	0	,,	20/-
,,	16 ..	184	5	0	,,	60/-

Spelter (ordinary)

		£	s.	d.		
Feb.	10 ..	13	15	0	dec.	7/6
,,	11 ..	13	16	3	inc.	1/3
,,	14 ..	13	13	9	dec.	2/6
,,	15 ..	13	12	6	,,	1/3
,,	16 ..	13	16	3	inc.	3/9

Spelter (Electro, 99.9 per cent.)

		£	s.	d.		
Feb.	10 ..	17	13	9	dec.	6/3
,,	11 ..	17	16	3	inc.	2/6
,,	14 ..	17	13	9	dec.	2/6
,,	15 ..	17	11	3	,,	2/6
,,	16 ..	17	15	0	inc.	3/9

Lead (soft foreign, prompt)

		£	s.	d.		
Feb.	10 ..	14	18	9	dec.	6/3
,,	11 ..	14	13	9	,,	5/-
,,	14 ..	14	15	0	inc.	1/3
,,	15 ..	14	17	6	,,	2/6
,,	16 ..	15	0	0	,,	2/6

Lead (English)

		£	s.	d.		
Feb.	10 ..	17	0	0	dec.	5/-
,,	11 ..	16	15	0	,,	5/-
,,	14 ..	16	15	0	No change	
,,	15 ..	17	0	0	inc.	5/-
,,	16 ..	17	0	0	No change	

Imports and Exports of Pig-iron, Castings, etc., in January, 1938, compared with January, 1936 and 1937

	January, 1936.	January, 1937.	January, 1938.	January, 1936.	January, 1937.	January, 1938.
Imports.	Tons.	Tons.	Tons.	£	£	£
Pig-iron—from British India	4,263	11,596	30,247	12,962	37,223	152,897
,, Other British Countries	—	—	—	—	—	—
,, Foreign Countries	2,443	2,960	55,085	12,238	18,400	306,752
Total	6,706	14,556	85,332	25,200	55,623	459,649
Castings and forgings	566	473	511	19,266	11,297	16,433
Cast pipes and fittings	93	161	79	2,190	3,093	2,320
Stoves, grates, etc.	45	88	51	5,004	4,857	4,782
Baths	673	656	504	16,332	15,490	13,037
Hollow-ware, all kinds	303	306	391	15,977	17,674	23,786
Exports.						
Pig-iron, forge and foundry	4,128	8,073	8,403	15,900	34,797	61,480
,, acid	2,584	4,969	3,112	8,729	21,578	23,176
,, basic	28	—	5	112	—	40
Total	6,740	13,042	11,520	24,741	56,375	84,696
Castings and forgings	360	373	167	12,623	13,465	8,880
Cast pipes and fittings, up to 6 in. diameter	4,372	3,793	6,703	48,420	43,352	73,697
,, ,, ,, over 6 in. ,,	4,508	2,494	8,876	42,554	19,920	84,067
Stoves, grates, etc.	887	910	749	44,884	47,209	42,697
Sanitary cisterns	246	294	271	7,789	9,297	10,309
Bedsteads, including tubes therefor	402	419	222	15,217	15,842	9,617
Hollow-ware	409	374	365	14,435	13,280	13,387

WILLIAM JACKS & COMPANY,
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.
CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.
PIG IRON
REGISTERED TRADE MARK
FOR EVERY TYPE OF CASTING
NON-FERROUS METALS
REFRACTORIES — COKE — SAND
FERRO-SILICON—FERRO-CHROME
WILLIAM JACKS & COMPANY,
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2.
TEESLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 6d. per line, first line in capitals counting two, average 6 words per line. Minimum charge for one insertion 3/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

FOREMAN Metal Patternmaker desires change, in similar capacity or progressive position attached to foundry. Sound practical experience, electrical, auto, textile and general. Technically trained in foundry practice and science, patternmaking, metallurgy and calculations, etc., including two City and Guilds. Keen, industrious, and strict disciplinarian. M.I.B.F. Age 32.—Box 796, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

FOUNDRY FOREMAN desires position. Practical and technical training all branches iron and non-ferrous work, thorough knowledge of cupola, metallurgy, mixing off metals for high-grade engineering castings. Good organiser, can produce castings at economical cost.—Box 798, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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